

AD-A237 920



DTIC

ELECTE

JUL 01 1991

c

D

1

A Study to Identify  
Variables Contributing to Length of Stay  
for Selected Diagnosis Related Groups (DRG)  
at Madigan Army Medical Center

A Graduate Management Project  
Submitted to the Faculty of  
Baylor University  
In Partial Fulfillment of the  
Requirements for the Degree

of  
Master of Health Administration

by

CPT Neal Evan Stockmyer, MS

7 June 1989

91-03798



"REPRODUCED AT GOVERNMENT EXPENSE"

DISSEMINATION STATEMENT A

Approved for public release;  
Distribution Unlimited

365

REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

1. REPORT SECURITY CLASSIFICATION N/A			1b. RESTRICTIVE MARKINGS N/A		
2. SECURITY CLASSIFICATION AUTHORITY N/A			3. DISTRIBUTION / AVAILABILITY OF REPORT UNCLASSIFIED/UNLIMITED		
4. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A					
5. PERFORMING ORGANIZATION REPORT NUMBER(S)			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION MADIGAN ARMY MEDICAL CENTER		6b. OFFICE SYMBOL (If applicable)		7a. NAME OF MONITORING ORGANIZATION U.S. ARMY-BAYLOR UNIVERSITY GRADUATE PROGRAM IN HEALTH CARE ADMIN.	
7. ADDRESS (City, State, and ZIP Code)			7b. ADDRESS (City, State, and ZIP Code) AHS SAN ANTONIO, TX 78234-6100		
8a. NAME OF FUNDING / SPONSORING ORGANIZATION		8b. OFFICE SYMBOL (If applicable)		9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
9. ADDRESS (City, State, and ZIP Code)			10. SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.
			WORK UNIT ACCESSION NO.		
11. TITLE (Include Security Classification) A STUDY TO IDENTIFY VARIABLES CONTRIBUTING TO LENGTH OF STAY FOR SELECTED DIAGNOSIS RELATED GROUPS (DRG) AT MADIGAN ARMY MEDICAL CENTER					
12. PERSONAL AUTHOR(S) STOCKMYER, NEAL EVAN					
13a. TYPE OF REPORT FINAL		13b. TIME COVERED FROM 7-88 TO 7-89		14. DATE OF REPORT (Year, Month, Day) 890607	
				15. PAGE COUNT 101	
16. SUPPLEMENTARY NOTATION					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) VARIABLES CONTRIBUTING TO LENGTH OF STAY		
FIELD	GROUP	SUB-GROUP			
19. ABSTRACT (Continue on reverse if necessary and identify by block number) This study examined the relationship between ten independent variables and the length of hospital stays of 400 cases which fell within four frequently occurring Diagnosis Related Groups (DRG) at Madigan Army Medical Center. The independent variables were patient category, marital status, day of the week admitted, day of the week discharged, preadmission testing, discharge planning, discharge destination, number of laboratory tests, number of radiological procedures, and number of consults. Additional DRG-specific independent variables were also included in the model. The additional variables were emergency admission, premature delivery, and passes in conjunction with the day of admission and/or discharge. Regression analysis was used to determine which variables were significantly associated with length of stay. Aspects of all variables, except marital status, emergency admission, and discharge destination, were found to be significantly associated with either longer or shorter lengths of stay for one or more of the DRGs. These results combined with additional analysis of the data indicated that there are physician practice patterns which will have to change under a DRG based resource allocation system.					
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS				21. ABSTRACT SECURITY CLASSIFICATION	
22a. NAME OF RESPONSIBLE INDIVIDUAL CPT NEAL E. STOCKMYER				22b. TELEPHONE (Include Area Code) (206) 967-6817	
				22c. OFFICE SYMBOL	



DEPARTMENT OF THE ARMY  
MADIGAN ARMY MEDICAL CENTER  
TACOMA, WASHINGTON 98431-5000

REPLY TO  
ATTENTION OF

HSJ-DCA

9 June 1989

MEMORANDUM THRU Deputy Commander for Administration, Madigan Army  
Medical Center, Tacoma, Washington 98431-5000

FOR Residency Committee, U.S. Army-Baylor University Graduate  
Program in Health Care Administration (HSHA-IHC), Academy  
of Health Sciences, Fort Sam Houston, Texas 78234-6100

SUBJECT: Graduate Management Project

In accordance with the instructions contained in the  
Administrative Residency Manual, an original and three copies of  
the Graduate Management Project along with the Report  
Documentation Page (DD Form 1473) are submitted by Captain Neal  
E. Stockmyer, Administrative Resident, Madigan Army Medical  
Center.

Enclosures

NEAL E. STOCKMYER  
CPT, MS  
Administrative Resident

"REPRODUCED AT GOVERNMENT EXPENSE"

## ACKNOWLEDGEMENTS

This study could not have been successfully completed without the help of several people. First, I extend my gratitude to Ms. Donna Cooper of the Special Studies Branch, U.S. Army Patient Administration Systems and Biostatistics Activity, and Mr. Mike Vanderlinde, Budget Analyst, at the University Hospital, University of Washington, for their assistance in obtaining the data necessary to select the cases used in the study. Major Rufus B. (Bernie) Chapman, Chief, Patient Administration Division, and his Inpatient Records Section personnel provided tremendous support in providing the 400 Inpatient records requested for review. I also appreciate the guidance of Mr. Troy Patience, Department of Clinical Investigations, in the statistical analysis of the data. Finally, I thank my preceptor, Colonel William F. Carroll, for giving me the latitude to select a topic in which I have a keen interest.

## TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....	1
LIST OF TABLES.....	iv
CHAPTER	
I. INTRODUCTION.....	1
Conditions Which Prompted the Study.....	1
Problem Statement.....	4
Objectives.....	4
Criteria.....	6
Assumptions.....	7
Limitations.....	8
Review of the Literature.....	8
Research Methodology.....	20
II. FINDINGS.....	37
DRG 125, Circulatory Disorders.....	37
DRG 222, Knee Procedures.....	42
DRG 359, Uterus and Adnexa Procedures.....	46
DRG 373, Vaginal Delivery.....	49
III. DISCUSSION.....	52
Significant Variables.....	52
Variables not Significant.....	58
Controllable versus Uncontrollable Variables.....	59
IV. CONCLUSIONS AND RECOMMENDATIONS.....	62
Conclusions.....	62
Recommendations.....	64
APPENDIX	
A. Diagram of Marchette and Holloman Length of Stay Conceptual Framework.....	68
B. Conceptual Framework for Length of Stay at Madigan Army Medical Center.....	69
C. Coding of Variables for Regression Model.....	70
D. Characteristics and Capabilities of MAMC and Candidate Facilities.....	71
E. Teaching Programs at MAMC and Candidate Facilities.....	73

"REPRODUCED AT GOVERNMENT EXPENSE"

F. Top 25 Frequently Occurring DRGs at MAMC, FY88.....	74
G. MAMC Length of Stay Data for Top 25 DRGs.....	75
H. University Hospital LOS Data for Selected DRGs.....	76
I. Data Collection Instrument.....	77
J. Descriptive Statistics, DRG 125.....	78
K. Correlation Matrixes of Selected Variables, DRG 125.....	80
L. Descriptive Statistics, DRG 222.....	81
M. Correlation Matrixes of Selected Variables, DRG 222.....	83
N. Descriptive Statistics, DRG 359.....	84
O. Correlation Matrixes of Selected Variables, DRG 359.....	86
P. Descriptive Statistics, DRG 373.....	89
Q. Frequency Distributions for Discharge Planning.....	93
WORKS CITED.....	94

## LIST OF TABLES

Table 1.	Previous Studies Reviewed.....	19
Table 2.	Operating Beds of Candidate Facilities.....	27
Table 3.	Average Daily Census of Candidate Facilities.....	28
Table 4.	Final Selection Criteria Data.....	29
Table 5.	Decision Matrix.....	30
Table 6.	LOS Comparison: MAMC vs University Hospital.....	32
Table 7.	Candidate DRGs.....	33
Table 8.	DRGs for the Study.....	34
Table 9.	Modifications to the Regression Model.....	36
Table 10.	Regression Analysis, DRG 125.....	39
Table 11.	Regression Analysis, DRG 222.....	44
Table 12.	Regression Analysis, DRG 359.....	48
Table 13.	Regression Analysis, DRG 373.....	52
Table 14.	Significant Variables.....	53

## Chapter I. INTRODUCTION

## Conditions Which Prompted the Study

The use of Diagnosis Related Groups (DRG) in Prospective Payment Systems (PPS) has been a part of the civilian health care industry since October 1, 1983 when they were implemented by Congress for Medicare payments. The purpose of the Medicare DRG based PPS was to curb the ever increasing costs of inpatient medical care for Medicare recipients. When Medicare was first implemented in 1965, it was estimated that annual costs for hospital care would reach \$8.8 billion by 1990, however, this target was surpassed in 1972 and estimates for 1990 were revised to over \$100 billion (Crawford 1984). Prospective pricing was determined as the method by which health care institutions would be forced to become more cost conscious.

In her 1984 article, Crawford predicted, "...in the future all hospitals, including those in the Veterans Administration, face substantial management changes in order to respond to a system of prospective pricing and reimbursement based on Diagnosis Related Groups." The Veterans Administration hospitals and medical centers implemented a program titled "Resource Allocation Methodology" in fiscal year 1985 to prospectively allocate resources based on DRGs. What Crawford did not predict was the implementation of such a system in military hospitals.

Congress passed Public Law 99-661 on November 14, 1986 which requires the Department of Defense to develop a DRG based resource allocation system for the three armed forces medical departments. The Office of the Secretary of Defense for Health Affairs

initiated a phased approach to implementing a new resource allocation system which was planned to span the five year period of Fiscal Years 1988 through 1992 (Triservice Performance Measurement Working Group 1987). A report prepared by the Triservice Performance Measurement Working Group titled "State-of-the-state of DRG Implementation Pursuant to P.L. 99-661" was distributed to all Army Medical Center and Medical Department Activity Commanders in November 1987 outlining the implementation of DRGs in the Army. Although the Triservice report provides a general implementation plan, it does not have all of the answers to questions of how to manage under a system based on Diagnosis Related Groups. We, the Army Medical Department, and particularly the individual Medical Treatment Facilities (MTF), are faced with developing ways to best adapt to DRG based resourcing.

In deciding how to best cope with DRGs, we can capitalize on the experiences of the civilian sector. However, there is a distinct difference between civilian and military hospitals. MTFs operate on a resource allocation method and do not have a profit motive. Civilian hospitals receive reimbursements for care provided to each patient and, even in the case of not-for-profit facilities, must generate revenues which exceed expenses to stay in business.

The best method for analyzing ways of reducing costs is to determine the standard and actual costs for each DRG, determine the difference between the two (the controllable variance), and develop methods for reducing the controllable variance (Helml 1988). However, one aspect of the difference between the civilian sector and the military is that the civilian sector has automated

systems which determine billing charges and costs for a particular patient and military hospitals can only estimate the average cost per patient at the service level, i.e., the average cost of an obstetrics patient or an orthopaedic patient. In the absence of actual patient level cost data, the question is, how do MTFs reduce costs?

One of the major results of DRGs in the civilian sector has been a significant reduction in lengths of stay which has resulted in reduced costs per inpatient episode. "Length of stay is only one variable affecting cost of hospitalization; however, the longer the stay, the greater the cost" (Marchette and Holloman, 1986). Although only one of the variables affecting costs, a study of the New Jersey DRG system found that reducing the mean length of stay accounted for most of the cost savings (Rosko and Broyles 1987). Under the cost reimbursement method, where the unit of payment was a patient day, additional days in the hospital usually meant increased profit; however, with a fixed prospective payment, additional inpatient days represent costs which will be avoided if possible (May 1985). Here a similarity in motives for reducing length of stay can be seen when comparing the civilian sector and the Army. Much like civilian hospitals, Army medical facilities received additional resources for each additional inpatient day under the Medical Composite Care Unit (MCCU) system. Extending the length of stay, particularly for minimal care patients, under MCCUs can be "profitable" since few resources are needed to maintain the patient at that stage of their inpatient episode. With a prospective resource allocation system, the incentive to keep patients a few extra days disappears.

Following the lead of the civilian sector, MTFs should determine what steps can be taken at the facility level to reduce lengths of stay and, subsequently, costs of inpatient care. Section 6, Suggested MTF Tasks, of the 1987 Triservice Performance Measurement Working Group report makes several recommendations about the types of activities which would facilitate the implementation of DRGs. Among these recommendations was "Examine length of stay (LOS) data" (Triservice Performance Measurement Working Group 1987).

### Problem Statement

The purpose of this study is to determine the variables significantly associated with inpatient lengths of stay at Madigan Army Medical Center (MAMC) for selected Diagnosis Related Groups (DRG).

### Objectives

The first objective was to review the literature to determine the experience of the civilian sector with DRGs. The review included previous studies and articles which examined variables associated with length of stay in civilian institutions. Articles relating to strategies employed by hospitals to reduce lengths of stay since the implementation of the DRG based Medicare Prospective Payment System and those addressing Utilization Review were also reviewed. The thrust of the literature review was to determine which variables were most likely to contribute to length of stay, thereby targeting the independent variables for this study, and to identify measures for controlling those variables.

The results of the literature review are discussed later in this chapter.

The second objective was to compare the private sector and Army inpatient delivery systems and identify similarities and differences. This comparison allowed the author to evaluate the applicability of the civilian experience with DRGs to the Army's health care delivery system. Although some major differences exist, there was sufficient commonality to support the application of the concepts in published studies and articles to the Army Health Care System.

The next several objectives are related to the methodology and are discussed at length in that section of the study and, therefore, will be described here in brevity. The major consideration in selecting the DRGs for this study was their length of stay. It was determined that the DRGs selected should have average lengths of stay which were significantly longer than at Madigan when compared to a similar civilian institution. Therefore, the next objective was to identify a similar civilian institution based on size, inpatient census, capabilities, and teaching programs. This was accomplished by establishing objective criteria for each of the four characteristics and ranking the civilian institutions considered.

The objective of selecting specific DRGs for the study was accomplished by comparing the lengths of stay and other characteristics for DRGs which occurred frequently at both Madigan and the selected civilian facility. The other characteristics included average patient age, mix of male/female patients, and DRG case mix indexes.

A conceptual framework and model for assessing the effects of the selected variables were obtained from previous published studies. The method of analysis selected was multiple regression. This method was best suited for determining the degree of association between the dependent variable (length of stay) and the independent variables.

The next objective was to collect and analyze data from Madigan's inpatient records to identify those variables which were significantly associated with length of stay for each DRG studied. This was accomplished by manually collecting the data from a random sample of records, developing a database, and computing the multiple regression equations and associated statistics with a software program. The variables found to be significant were categorized as either controllable or uncontrollable.

The findings were discussed, conclusions drawn, and recommendations made on how the results of the study could be used to adapt to the DRG environment.

### Criteria

Criteria had to be established for several aspects of the study. The first was in the selection of a civilian facility which was similar to Madigan Army Medical Center. The civilian facilities were compared and ranked on an objective basis for each of four characteristics. The facility with the lowest cumulative score was considered to be the most like Madigan. The criteria for all statistical tests is that an alpha level of .05 must be obtained for significance. Finally, independent variables which

are found to be significantly associated with length of stay are classified as controllable or uncontrollable using face validity.

### Assumptions

Congress mandated the implementation of a DRG based resource allocation system in the Department of Defense (DOD) but none of the documents reviewed indicate the intent of the mandate. Therefore, it is assumed that the primary goal of DRG implementation in the DOD is to reduce the costs of inpatient care.

This study also assumes that private sector lengths of stay are more appropriate standards for the selection of DRGs for the study than lengths of stay at military treatment facilities. The former were developed under the DRG prospective payment system and the latter were developed under a system (Medical Composite Care Units) which rewards longer lengths of stay.

Based on the experience of the civilian sector in reducing the cost of inpatient care through reduced lengths of stay, it is assumed that this approach is an appropriate way to reduce costs in Army inpatient treatment facilities as well. In addition, it is assumed that the recommendations which would result in shorter lengths of stay should not affect the overall quality of care the patients receive. This last assumption is supported by the results of published studies which found that the quality of care was not compromised by reduced lengths of stay (Egdahl 1983; Vander Salm and Blair 1984; Cohen, Schaeffer, Chen, and Wood 1986).

Finally, in collecting the data for selecting a civilian hospital that was similar to Madigan, it was assumed that the information in the source documents (the AHA Guide and the Directory of Graduate Medical Education Programs) was accurate.

### Limitations

There are three limitations associated with this study. First, the DRGs selected for analysis must be limited to those where the average age and mix of male and female patients at Madigan are similar to the patients at the civilian facility. This controls for any effects of age or sex on length of stay. Second, the sample of patients selected is not representative of all patients treated at Madigan and, therefore, restricts the ability to generalize the results. Third, the number of variables to be examined and the sample size are limited by the capabilities of the software used to perform the statistical analysis.

### Review of the Literature

The implementation of a DRG based Prospective Payment System (PPS) for Medicare inpatient episodes placed hospitals in a defensive position. With a predetermined dollar amount for each case, hospital administrators were faced with developing strategies which would ensure that reimbursements exceeded expenses. Cost control measures began to appear in the health care journals immediately following the announcement of the DRG system.

The New England Journal of Medicine published an article in 1983 which pinpointed several areas which could reduce the cost of inpatient care. The first was the reduction of length of stay

through greater efficiency. Egdahl said that while there was some cost savings potential in curbing outlier cases, the bigger goal for cost containment was to find ways to reduce established length of stay norms a moderate amount in the direction of greater efficiency (1983). A study conducted later showed that the initial response of hospitals to the DRG Prospective Pricing Mechanism in New Jersey (the forerunner to the Medicare PPS) was to increase admissions and decrease length of stay (Rosko and Broyles 1987). Egdahl also identified the use of laboratory tests as an area which could be scrutinized more closely. In this area, he recommended the reassessment of established testing routines to eliminate antiquated or marginally useful tests (Egdahl 1983). Later articles went further to suggest that testing be accomplished on an outpatient basis prior to admission thereby reducing the length of stay and the associated costs of an additional inpatient day (Jay 1984, Brennan 1985). Egdahl's projections in cost reduction also included shifting some surgical procedures to the ambulatory setting and creating financial incentives for physicians, e.g., providing economic rewards to clinical services that meet established efficiency targets (1983).

An article in 1984 supported some of the ideas put forth by Egdahl in his 1983 publication. The author said that the physician had a responsibility "...to find ways of keeping costs in line with DRG rates" (Jay 1984). Jay, a physician himself, identified the decrease of laboratory services and minimizing length of stay as two of five ways to reduce costs (1984). His approaches to reduced lengths of stay included preplanning

elective admissions and concurrent Utilization Review. He also noted the trend to increase preadmission testing.

While the previously mentioned articles were concentrating on actions which could be implemented in a relatively short period of time and would achieve timely results, the academicians were looking at long term strategies. A professor and an assistant professor of the Health Systems Management Group, School of Organization and Management, Yale University, saw education as the way to manage under DRGs. They proposed incorporating instruction on DRGs into the curriculum of health services administration programs, continuing education programs, and the education of physicians (Thompson and Grazier 1984). The authors described the latter as "...the most difficult, and still hazy task...". Their reluctance in educating physicians was accurate. Experience has shown that trying to educate physicians on prudent use of laboratory test yields short term results at best (Portugal and Winkelman 1989).

Nurses were also looking at the DRG issue but from a slightly different perspective. They were concerned with how DRGs would affect the practice of inpatient nursing. Feldman and Goldharber conducted interviews with six New Jersey nursing vice presidents and directors using open-ended questions (1984). The results indicated a recognition of the role of discharge planning in the effort to reduce length of stay. They recognized not only a need for an increase in discharge planning activities, but also the need to initiate the process on the first day of the admission. One of the authors' conclusions was that there were strong

indications that some care would shift from the inpatient setting to home health (Feldman and Goldharber 1984).

Another nurse, who looked at how her profession could contribute to shorter lengths of stay in critical care cases, published an editorial in Dimensions of Critical Care Nursing in 1985. She identified the following six areas in which a critical care nurse could develop expertise which would decrease patient stay; (1) physical assessment skills, (2) monitoring skills, (3) patient teaching, (4) admission screening, (5) discharge planning, and (6) developing home care (Johnson 1985). Skills in these areas were said to enable the nurse to assist in early identification and treatment of complications, increase patient compliance, participate in development of utilization criteria for critical care, prepare patients for transition to home, and identify patients who would benefit from early discharge to home.

The emphasis on financial management was new to the health care industry and many of the skills needed to effectively address the business issues were lacking. Hospitals turned to the experts and engaged consultants to assist them in developing ways to cope with prospective payment (Brennan 1985). Brennan compiled the results of interviews with key executives in the health care planning divisions of the nation's "Big 8" accounting firms. A major theme intertwined in the comments of these executives is reduced lengths of stay. Jack Beult, a partner at Price Waterhouse is quoted as saying, "...if a hospital can speed up diagnosis, reporting, and treatment, it can cut length of stay and improve its financial position" (Brennan 1985). Preadmission testing is cited by executives of Cooper & Lybrant and Arthur

Anderson & Company as contributing directly to shorter stays and their primary recommendation to clients, respectively.

The literature reviewed thus far were articles which relied primarily on expert opinion and anecdotes. However, at the same time these articles were published, other authors had been conducting and publishing studies which provided more insight into ways to reduce inpatient lengths of stay and, subsequently, costs.

Vander-Salm and Blair demonstrated the relationship between shorter lengths of stay and cost savings in their concurrent study of coronary artery bypass patients. The purpose of their study was to determine (1) if the postoperative Intensive Care Unit (ICU) stay could be reduced to one day after a routine Coronary Artery Bypass Graft (CABG) operation with no compromise in patient care or safety and (2) what cost savings would result from the reduction in ICU postoperative days from two to one (Vander-Salm and Blair 1984). The study was conducted with thirty-seven randomly selected coronary artery bypass patients. Eighteen of the patients remained in the ICU for the routine two day postoperative period while the remainder stayed only one day. The results of the study showed that there were no differences in the number or types of complications experienced by each group. Two areas where costs savings were found to be statistically significant were room costs and costs for arterial blood gases (Vander-Salm and Blair 1984). This study helped to establish that shorter lengths of stay can contribute to reduced costs without a reduction in the quality of care.

The relationship between length of stay and costs are reinforced in a study by a group of physicians at the Long Island

Jewish-Hillside Medical Center in Stony Brook, New York. The researchers performed the study to "...examine the financial components of a common surgical DRG that would be unprofitable, examine the appropriateness of the components of care, and propose strategies for cost containment without sacrificing the quality of care" (Munoz, Margolis, and Wise 1986). A total of 215 patients in DRG 162 (inguinal and femoral hernia repair, age 18 to 69 years without complications) treated at Long Island Jewish-Hillside Medical Center during the period 1 January to 31 December 1983 were studied. Preadmission testing was performed for all elective procedures (208 of 215). The study revealed that significant savings could be realized by reducing the average length of stay for this DRG. A savings in room and board of \$35,475 at their hospital could be realized by decreasing the mean length of stay from 3.6 to 3.1 days (Munoz et al 1986). They also found that a decrease in unneeded ancillary services combined with a shorter length of stay for this unprofitable DRG could result in enough savings (approximately \$58,800) to make it profitable. While a decrease in ancillary services results in substantial savings, 60% of the cost savings ( $\$35,475 / \$58,800$ ) can be attributed to shorter lengths of stay alone.

A study published in 1985 examined the role of patient teaching status, controlling for DRG, demographic characteristics, and severity of illness in predicting hospital charges and length of stay (Jones 1985). Four DRGs, comprised of 823 patients, were studied. The author developed three regression models to conduct the data analysis. Each successive model added additional independent variables. The dependent variables were total

hospital charges, routine charges, diagnostic charges, treatment charges, charges per day, and length of stay. The dependent variable of interest to this study is length of stay. The first regression model included the dependent variables of patient teaching status, while controlling for DRG, and explained only 40% of the variance in length of stay. Differences in length of stay were found significant at the 0.05 level for one of the four DRGs. Additional analysis revealed that the diagnostic group, type of anesthesia, use of consultations, patient age, number of complications, health status at admission, marital status, and place of residence were the most important predictor variables for length of stay variations (Jones 1985). The author did not report any analysis of correlations between length of stay and costs. However, this study does suggest that there are many variables which may contribute to length of stay.

Two other variables not examined in the previous studies, which were thought to contribute to length of stay, are physician practice and severity of illness. McMahon and Newbold analyzed the relationship between resource use (the dependent variable), illness severity, and the physician (the independent variables) in a multi-hospital study (1986). The researchers chose length of stay as the measurement for resource use and disease staging for severity of illness. The third variable, physician, is self explanatory. The analysis examined the variation of length of stay within selected DRGs. Length of stay outliers were excluded from the study because, in the words of the authors, "Such cases [outliers]...may represent unique patient types and must be evaluated on their own merits" (McMahon and Newbold 1986). The

results indicated that physician practice explained more variability in length of stay than did severity of illness. While physician practice was found to be statistically significant for most of the DRGs studied, severity of illness was not. The authors admit that there are other independent variables which impact on length of stay and that more basic research is needed to identify them.

Probably the most ambitious study found during the literature search was conducted by two nurses, Marchette and Holloman, who investigated the relationships between ten independent variables and length of stay. The researchers looked at four aspects of discharge planning, admission day of the week, discharge day of the week, discharge destination, age, gender, and diagnosis as the independent variables. A retrospective study was performed using data from clinical records of 500 patients with a diagnosis of either arteriosclerotic heart disease, myocardial infarction, congestive heart failure, or cerebrovascular accident. The diagnostic groups each had 100 patients. Multiple regression was performed on the entire sample and then on each of the diagnostic groups. Their analysis revealed several interesting relationships. First, that for every area of discharge planning performed by the nurse, there was a decrease of 0.8 days in length of stay. Second, for every day that discharge planning was postponed, whether it was to be performed by the nurse or a social worker, the hospital stay increased by 0.8 days. Third, those patients who received discharge planning by social workers had an average length of stay 7.6 days longer. In regards to discharge destination, they found that patients discharged to home had

shorter lengths of stay while those discharged to a nursing home had hospital stays of 10 to 12 days longer. However, the only variables which were significantly correlated with length of stay were (1) age, (2) discharge to nursing homes, and (3) whether or not patients received discharge planning by a social worker. This regression model with ten independent variables could only explain 21% of variation in lengths of stay (Marchette and Holloman 1986). Although this study found some significant relationships, the model is not a good predictor of length of stay for the population studied and supports the conclusions of other studies that there are many possible variables which can affect length of stay.

A study published in 1987 in the Journal of the American Medical Association added yet another variable to be considered in explaining variations in lengths of stay. The authors examined the records of 47 pre-PPS and 23 post-PPS patients treated for hip fractures during the five year period of 1981 through 1985 to determine if there had been a significant decrease in length of stay since the implementation of the Medicare PPS and, if so, why (Fitzgerald, Fagan, Tierney, and Dittus 1987). The results supported their hypothesis that the average hospital stay would be significantly shorter after PPS implementation. Furthermore, they attributed the reduction in length of stay to a shortening of the interval between physical therapy and discharge, during which time the mean number of therapy sessions during hospitalization decreased from 9.7 to 4.9 ( $P = .0004$ ) (Fitzgerald et al 1987).

One commonly talked about method used to reduce length of stay is the use of same day admissions. Hall investigated the effect of a same day admission program for cholecystectomy patients at

Methodist Hospital of Indiana in Indianapolis (1987). The same day admission program included preadmission testing, patient education about the procedure, and an admission history and physical on an outpatient basis. He reports a reduction in mean length of stay from 3.2 to 2.5 days but does not state if this is statistically significant and, therefore, limits the use of his results.

Another term heard in connection with the Prospective Payment System is patient shifting. This approach to reducing length of stay and avoiding additional costs was studied by Carroll and Erwin (1987). They expected to find an increase in patient shifting from acute care hospitals to long term care facilities (LTCF) since PPS. The researchers collected data from the records of 195 pre-PPS and 158 post-PPS patients. Patients were selected based on admission to a convenience sample of ten LTCFs. Patients included in the study had to be Medicare patients admitted to a LTCF directly from the hospital. The results of the data analysis using Chi-square and t-tests indicated no significant differences between the two groups. The statistics did not show that post-PPS patients were admitted any sooner or sicker than their pre-PPS counterparts (Carroll and Erwin 1987).

The topic of patient shifting was studied by other researchers and the results showed that a financial disincentive exists under DRGs for teaching hospitals to accept surgical transfer patients from other acute care hospitals (Munoz, Soldano, Gross, Chaflin, Mulloy, and Wise 1988). The study examined the average costs of surgical patients transferred in from other facilities versus surgical patients admitted directly to the teaching hospital.

Transfer patients had both significantly higher costs and lengths of stay. The transfer patients generated a net loss while those admitted directly to the hospital under the same DRG generated a profit (Munoz et al 1988). Munoz et al did not demonstrate that patient shifting was being used to avoid high cost cases but that there was incentive to avoid accepting surgical patients from other hospitals.

A compilation of the studies reviewed are presented in Table 1, Previous Studies Reviewed. This table summarizes, in chronological order, the efforts by the cited authors to explain the relationships between (1) reduced lengths of stay and reduced costs, and (2) variables associated with length of stay.

Table 1.

## Previous Studies Reviewed

Author(s)	Year	Type of Study	Method of Analysis	Variables Examined
Vander-Salm and Blair	1984	Concurrent	t-test	LOS, Costs, Quality
Jones	1985	Retrospective	Regression	LOS, Costs, DRG, Severity of Illness, Demographics, Patient Teaching Status
Munoz et al	1986	Retrospective	Mean $\pm$ SEM	LOS, Costs, Ancillary Tests
Marchette and Holloman	1986	Retrospective	Regression	LOS, Discharge Planning, Age, Discharge Day, Admission Day, Diagnosis, Gender, Discharge Destination
McMahon and Newbold	1986	Retrospective	Regression	LOS, Severity of Illness, Physician
Rosko and Broyles	1987	Retrospective	Regression	LOS, Costs
Fitzgerald et al	1987	Retrospective	t-test, Chi-square	LOS, Physical Therapy
Hall	1987	Retrospective	Descriptive	LOS, Same Day Admission
Carroll and Erwin	1987	Retrospective	Chi-square	LOS, Patient Shifting
Munoz et al	1988	Retrospective	Mean $\pm$ SEM	LOS, Patient Shifting, Costs

\*LOS = Length of Stay, SEM = Standard Error of the Mean

### Research Methodology

The research methodology was divided into five steps. First, it was necessary to compare the similarities and differences of the civilian and Army health care delivery systems. This would indicate what aspects of previous studies performed in the private sector could be applied to the military setting. The comparison also helped to identify other variables for the study of lengths of stay at Madigan. The next step was model development, which was based on previous studies. The third step in methodology was to identify a civilian hospital in the Seattle-Tacoma area which was similar to Madigan Army Medical Center. This was followed by the selection of the DRGs to be studied. The fifth and final step in methodology was the collection and analysis of the data.

### Comparison of the Civilian and Army Health Care Systems

The comparison of the two health care systems includes three general areas; resourcing, utilization, and populations served. References to the civilian health care system in this discussion refer to for-profit and not-for-profit acute care hospitals. These type of hospitals have three major sources of reimbursements for inpatient care; private insurance companies, individual patients, and the government. The latter category includes state and federal funds through the Medicare and Medicaid programs. The degree of dependency on any particular source of reimbursement varies by hospital. For example, rural hospitals may rely more on Medicare because of the higher percentage of elderly in that population while an inner city public hospital may depend more on Medicaid to pay for the larger number of indigent care cases.

Each hospital, however, has several sources of funds. The Army Health Care System has one primary source of funds allocated by Congress through the Defense Budget.

Both the civilian and Army systems try to affect the flow of incoming revenues. The civilian sector received reimbursement for inpatient care based on charges prior to the introduction of prospective payment systems (PPS). If a civilian institution wanted to maximize their income they could maintain a high occupancy rate, extend lengths of stay, raise their charges, or combine these methods. Individual Army hospitals, however, do not have the ability to raise patient charges to increase their funding. They do have the ability to affect inpatient census and lengths of stay. As mentioned in the introduction, there is a similarity between the pre-DRG civilian system and the Army's system of resourcing based on Medical Composite Care Units (MCCU). The Army health care facilities and their civilian counterparts would receive additional funds for each day of hospitalization. Therefore, hospitals in both sectors were rewarded for maintaining a high inpatient census and keeping patients in the hospital. The implementation of DRG based PPS, first in the civilian sector, had major effects on the incentives for providing inpatient acute care. With a fixed amount of money associated with each type of case, civilian hospitals had to find ways of making a profit through cost reduction. Faced with the implementation of a DRG resource allocation method, Army hospitals must find ways of reducing costs as well. The civilian sector found that reducing lengths of stay was one way of achieving this goal and the same approach can be applied to Army acute care facilities.

Financial incentives affect utilization of resources.

Resource utilization can be viewed as bed occupancy or use of ancillary services. The relationship between finances and bed occupancy has already been discussed. There is a parallel between the use of ancillary services in the pre-DRG civilian environment and the military. For example, Portugal and Winkelman described the hospital laboratory environment of the late 1970's and early 1980's as when revenue generation was guaranteed, the scope of testing was unlimited, extraordinary service levels were provided, and there was a strong commitment to teaching (1989). This same description could be applied to Madigan Army Medical Center today. The MAMC laboratory, like all Army laboratories, receives workload credit (and the associated resources) for all procedures performed, panels of tests are ordered whether all tests on the panel are needed or not, there are no controls over the level of service, and many tests not medically indicated are ordered for teaching purposes. Supply consumption and staffing levels are also measures of resource utilization but are not among the variables that were examined in the studies reviewed.

Differences in the population served by Army facilities can be significantly different than the population served by a civilian hospital in the same community. The active duty population is generally young and healthy. There are many who are single and those who are married have spouses of similar age. While there are physical standards for retention in the Army, there are no controls over the health of the spouses and children of active duty soldiers. However, family members have virtually unlimited access to free outpatient services which may result in a higher

health status when compared to their civilian counterparts. Therefore, the population of the active duty Army and their families is probably younger and healthier than the general population in the surrounding community.

Army health care facilities also treat the retired military population in the area. The number of retirees and their family members served is restricted by limited resources. The active duty members and their families have priority while retirees must obtain care in many areas on a space available basis. A possible result is that the patient population served at MAMC and some other military treatment facilities is likely to have fewer elderly patients than the average civilian hospital.

The differences in populations can impact directly on lengths of stay. A common example used to illustrate this point is the situation where a young, single soldier who lives in the barracks is admitted to the hospital for care. After obtaining the optimum benefit from an inpatient setting, he is ready to be discharged. However, if he requires continued care which can be provided in a home, his hospitalization must be extended because he has no home to which he can be discharged nor a family to assist in home care. The result is a longer length of stay. Conversely, soldiers may be admitted to the hospital for relatively minor conditions which, in the civilian sector, do not warrant admission. The result here is a low severity case with a short length of stay.

There are sufficient similarities in the civilian and military system to apply the principles of the civilian sector experience with DRGs to the military health care system. However, because of the possible age differences and severity of cases in the

populations served, it is necessary to consider this factor in selecting the DRGs for study.

### Model Development

The conceptual framework for this study is based on that published by Marchette and Holloman (1986) (see Appendix A). As their framework shows, there are many possible variables which can affect length of stay. However, what is important is to identify those variables which explain most of the variance in lengths of stay. Based on the findings in the literature and characteristics of the patient population at Madigan, a conceptual framework for this study was developed and is presented in Appendix B.

The model used for assessing the effects of selected variables on length of stay is similar to those used in previous studies (Jones 1985; McMahon and Newbold 1986). The approach is multiple regression analysis where length of stay is the dependent variable and the independent variables are patient category, marital status, day of the week admitted, day of the week discharged, preadmission work-up, discharge planning, discharge destination, number of laboratory tests, number of radiological procedures, and number of consults. The hypothesized relationship is as follows:

$$\text{Length of stay} = f (\text{patient category} + \text{marital status} + \text{day of the week} \\ \text{admitted} + \text{day of the week discharged} + \text{preadmission} \\ \text{work-up} + \text{discharge planning} + \text{discharge destination} \\ + \text{number of laboratory tests} + \text{number of radiological} \\ \text{procedures} + \text{number of consults})$$

In developing the regression model, the dependent variables are coded as binary where possible. Appendix C shows each variable and how it was coded. The resulting regression model has one dependent variable and thirty independent variables. The regression model is presented below.

$$Y = a_0U + b_1X_1 + b_2X_2 + b_3X_3 \dots + b_{30}X_{30}$$

Where  $y$  = length of stay and  $X_1$  through  $X_{30}$  are the coded linearly independent predictor variables.

#### Selection of Civilian Institution

A civilian facility in the Seattle-Tacoma area was identified using size, average census, capabilities, and teaching mission. These variables can affect both the patient mix and the length of stay and, therefore, should be similar to MAMC. The characteristics of MAMC were reviewed and compared to other facilities in the area. Location was used as one criteria for the selection of the civilian hospital to control for any geographical differences.

In addition to location, other characteristics of Madigan Army Medical Center had to be defined before a comparison could be made. MAMC can be described as a 402 operating bed teaching facility with an average census of 286 patients. It is a short-stay, general medical and surgical hospital. Data concerning the size, census, and capabilities of local hospitals was obtained from the 1988 AHA Guide. Candidate facilities were selected based on the following characteristics:

- \* Teaching facility
- \* Short-stay facility
- \* Size similar to MAMC
- \* Average census similar to MAMC
- \* General medical and surgical facility

Based on these characteristics, four potential facilities were identified; University Hospital, Swedish Hospital Medical Center, Harborview Medical Center, and Providence Medical Center. All facilities are located in Seattle.

The selection criteria used to identify the one best civilian facility are listed below.

1. Number of operating beds. The number of operating beds of each candidate facility is compared with the total operating beds at MAMC. The facility with the least absolute difference in beds is considered to fit this criteria best. Conversely, the facility with the greatest absolute difference is considered to be the worst.

2. Average daily census. A comparison is made of the average daily census at each candidate facility to that of MAMC. As with the first criteria (operating beds), an absolute difference is computed. The facility with the least absolute difference meets this criteria best and the greatest absolute difference is considered to be the least like MAMC for this criteria.

3. Number of capabilities the same as MAMC. The capabilities of each facility is used to evaluate their similarity to MAMC as well. The facility which offers the greatest number of services that are also offered at MAMC best fits this criteria.

4. Number of training programs the same as MAMC. An evaluation of teaching mission is accomplished by identifying the teaching programs at MAMC and the candidate facilities. A comparison is made between the teaching programs at MAMC and those at the other hospitals. The facility which has the greatest match of individual programs to those offered at MAMC best fits this criteria. Facilities with less matching programs are considered less like MAMC.

MAMC has 402 operating beds. The definition of operating beds used is found in the AHA Guide: "Number of beds, cribs, and pediatric and neonatal bassinets regularly maintained (set up and staffed) for inpatients...; does not include bassinets for normal newborn infants." Table 2 shows the number of operating beds for each candidate facility followed by the absolute difference between their operating beds and MAMC's.

Table 2.

Operating Beds of Candidate Facilities

<u>Name of Facility</u>	<u># Operating Beds</u>	<u>Absolute Difference</u>
University Hospital	381	21
Swedish Hospital Med Cntr	597	195
Harborview Medical Center	312	90
Providence Medical Center	376	26

The data shows that the facilities which are closest to MAMC in size are University Hospital, Providence, Harborview, and Swedish respectively.

The daily census at MAMC averages 286 patients. The average daily census of the candidates, along with the absolute differences from MAMC's average census, is displayed in Table 3. The data from Table 3 reveals that Harborview is nearest to MAMC in average daily census followed closely by University Hospital. Providence is third with a difference of 36 beds and Swedish is clearly least like MAMC for this criteria.

Table 3.

## Average Daily Census of Candidate Facilities

<u>Name of Facility</u>	<u>Average Census</u>	<u>Absolute Difference</u>
University Hospital	296	10
Swedish Hospital Med Cntr	443	157
Harborview Medical Center	277	9
Providence Medical Center	250	36

Relative capabilities of each facility were analyzed by extracting data from the AHA Guide and arraying it next to the capabilities of MAMC (see Appendix D). This revealed that MAMC offers thirty-nine of the fifty-four services listed in the AHA Guide. Swedish Hospital Medical Center had the most similar services matching thirty-two of the thirty-nine available at MAMC. The next closest was Providence Medical Center with thirty matching services followed by a tie between University Hospital and Harborview Medical Center, each with twenty-six.

The next selection criteria was to determine which of the four hospitals had a teaching mission which best reflected that of MAMC. In assessing the teaching mission, all categories of

programs, i.e., internships, residencies, and fellowships, were included. Information about teaching programs operating at MAMC was obtained from the Graduate Medical Education Coordinator. A list of teaching programs offered at the candidate facilities was compiled from the 1988-1989 Directory of Graduate Medical Education Programs. This data was arrayed for comparison (see Appendix E). University Hospital had twelve training programs that were the same as MAMC's, Swedish and Harborview each had five, and Providence only had three.

A decision matrix is used to determine the rank order of each candidate facility. First, the data for the final selection criteria is presented in Table 4.

Table 4.

**Final Selection Criteria Data**

Facility	Diff in Beds	Diff in Census	Capabilities	Training
University	21	10	26	12
Swedish	195	157	32	5
Harborview	90	9	26	5
Providence	26	36	30	3

From the information in Table 4, a decision matrix, rank ordering the hospitals for each criteria, was constructed (see Table 5). Values begin with "1", indicating best fit for that criteria, and descends to "4" which represents worst fit. In cases where two hospitals have the same values for a given criteria, the rankings are added together and averaged. The facility with the least total points is the one which best meets

the collective criteria. Based on this approach, University Hospital, with a total score of 6.5, is the facility selected as the one whose lengths of stay would be used to select the DRGs for the study.

Table 5.

## Decision Matrix

<u>Facility</u>	<u>Diff in Beds</u>	<u>Diff in Census</u>	<u>Capabilities</u>	<u>Training</u>	<u>Total</u>
University	1	2	2.5	1	6.5
Swedish	4	4	1	2.5	11.5
Harborview	3	1	2.5	2.5	9.0
Providence	2	3	4	4	13.0

Selection of Diagnosis Related Groups

The DRGs selected for the study had to meet five criteria. First, they had to be in the top 25 most frequently occurring DRGs at MAMC. Low occurring DRGs would not provide a sufficient sample nor would they have a significant impact on resource utilization (assuming they are not extremely high cost DRGs). Second, the length of stay at Madigan had to be significantly longer than the length of stay at University Hospital. This is based on the assumption presented earlier that civilian lengths of stay are an appropriate standard. Third, the patient populations for each DRG had to have a similar mix of males and females to control for the effects of sex. Fourth, the average age of the patients at each facility had to be similar for each DRG to control for age. Fifth, the DRG case mix indexes at Madigan and University Hospital

were comparable. The use of DRG case mix indexes attempts to control for the severity of cases.

A list of the top twenty-five most frequently occurring DRGs at MAMC for fiscal year (FY) 1988 was obtained from the U.S. Army Patient Administration Systems and Biostatistics Activity (PASBA) (see Appendix F). PASBA also provided data on the average length of stay, the length of stay standard deviation, average age of patients, number of male patients, number of female patients, case mix index, and total number of dispositions for each of the twenty-five DRGs (Appendix G). The same FY 88 statistical data for these 25 DRGs was obtained from University Hospital (Appendix H) and compared to MAMC figures.

First, the respective lengths of stay for each DRG were tested to determine if a significant difference existed. DRG 351, Male Sterilization, was excluded from the analysis because University Hospital had no cases for this DRG. The lengths of stay were compared using a  $t$  test for unequal  $n$ -sizes. There were six DRGs where MAMC's average length of stay was significantly longer than that of University Hospital. The lengths of stay for nine DRGs had no significant difference and the remaining nine were found to have significantly shorter lengths of stay at MAMC. The average lengths of stay,  $t$  values, and probabilities are displayed in Table 6.

Five of the nine DRGs where MAMC had significantly shorter average lengths of stay also had a lower case mix index and lower average patient age. Two additional DRGs had lower ages combined with a higher case mix index and the remaining two DRGs had both a

higher case mix index and average age. The data was not available to assess the significance of these differences.

Table 6.

LOS Comparison: MAMC vs University Hospital

DRG	MAMC	UH	df	t	p<
39	2.46	3.06	190	-1.75	.05
88	4.27	5.14	204	-.62	ns
125	4.22	2.64	253	3.44	.001
183	1.93	3.45	526	-4.50	.001
187	1.57	2.20	221	-.99	ns
222	5.29	3.71	219	1.72	.05
225	2.05	3.13	231	-2.40	.01
243	9.19	12.18	313	-3.18	.001
359	6.42	4.52	232	3.83	.001
370	5.66	8.30	489	-4.83	.001
371	4.65	5.30	343	-1.49	ns
372	4.53	4.14	749	1.27	ns
373	3.15	2.37	2640	6.99	.001
379	2.44	5.19	654	-8.49	.001
381	1.27	2.61	194	-6.33	.001
382	1.13	1.00	230	.48	ns
383	2.92	4.52	672	-4.69	.001
388	4.96	3.86	277	1.41	ns
389	4.76	5.70	403	-1.58	ns
390	3.03	2.61	1889	6.29	.001
391	2.80	2.16	1493	11.78	.001
410	3.18	3.01	459	.39	ns
467	1.92	1.78	445	.84	ns
468	7.85	10.73	330	-2.16	.05

ns = not significant

The six DRGs identified as having significantly longer lengths of stay at MAMC were considered for the study. Additional evaluation of these had to be performed to determine which fit the remaining criteria. DRGs 390 (Neonates with other significant problems) and 391 (Normal newborns) were determined to be unsuitable for this study. Prior studies did not examine infant cases and the application of the variables being examined in this

study to these type cases is inappropriate. Therefore, the remaining four DRGs were compared on the basis of case mix index, average age of patients, and mix of male and female patients (see Table 7). Differences in case mix index and average age were computed by subtracting University Hospital's statistic from MAMC's. Detailed data on average age of patients and the case mix indexes was not available and, therefore, these variables could not be tested for statistically significant differences. In terms of real numbers, there is little difference in these two variables. A comparison of the mix of male and female patients for DRGs 125 and 222 was conducted by computing a Chi-square statistic. In both cases, the difference failed to achieve an alpha level of  $<.05$  thereby indicating that the patient populations were similar in their respective mix of male and female patients. Since all four DRGs reasonably fit the selection criteria, it was decided to examine all of them in the study. A list of the DRGs and their titles are found in Table 8.

Table 7.

## Candidate DRGs

Code	Difference in CMI	Difference in Avg Age	MAMC M/F	UH M/F
125	.1268	-2.4	77/23	68/32
222	.1243	0.5	78/22	67/33
359	.1032	-2.9	0/186	0/48
373	.0846	-0.1	0/1633	0/1009

Table 8.

## DRGs for the Study

Code	Title
125	Circulatory Disorders Exc AMI, w/ Card Cath w/o Complex Diag
222	Knee Procedures Age <70 w/o C. C.
359	Uterus & Adnexa Proc for Non-Malignancy, Age <70 w/o C. C.
373	Vaginal Delivery without Complicating Diagnosis

Data Collection and Analysis

A list of randomly selected cases for each DRG was obtained from PASBA. The "n" size for each of the four DRGs was 100, totalling 400 cases for the study. Each record was reviewed and coded by the author and, therefore, eliminates any questions of inter-rater reliability.

The data was extracted from the records manually using the data collection instrument at Appendix I. Length of stay and patient category were recorded from the Inpatient Treatment Record Cover Sheet (ITRCS). Length of stay was based on the number of "bed days" recorded on the ITRCS. "Sick days" were not used because they include convalescent leave days and, therefore, do not represent the true length of stay. Marital status was determined from information contained on the ITRCS and the Admissions Coding Form. The day of the week admitted and discharged was determined by taking the dates on the ITRCS and using a calendar to convert them to the day of the week. Whether a preadmission work-up was performed was determined by examining the request dates of ancillary tests. If tests were requested on

a date prior to the date of admission, then it was considered preadmission testing. Evidence of when discharge planning began was collected from the DA Forms 3888 (Medical Record - Nursing Assessment and Care Plan) and 3888-1 (Continuation). Discharge planning begins with the identification of discharge needs; this first step is addressed on these forms. The date of the entries on the two forms was compared to the date of admission to calculate when discharge planning began. The patients discharge destination was determined from a combination of the ITRCS, the Narrative Summary, the physician's discharge note, and the nursing discharge note. The number of laboratory tests were calculated by counting the number of laboratory results in the record. Tests were counted individually. Therefore, if a profile such as a 909 (Lytes+) was used, it counted as eight tests since it includes that many individual tests; other profiles have more or less. The number of radiological procedures were determined similarly by counting the number of individual examinations requested. Finally, the number of consultations was extracted from the record by counting the number of consultation sheets. Consultations requested as part of outpatient follow-up treatment were not counted since they were not part of the inpatient treatment.

In addition to the variables in the basic regression model, data was collected on DRG-specific variables. For DRG 125 an additional variable of "Emergency Admission" was coded as a binary variable. "Pass" was included for DRGs 222 and 359 for the number of pass days (a continuous variable) that were in conjunction with the day of admission or the day of discharge. DRG 373 had an additional variable of "Prematurity" which was coded binary.

After the data for the variables had been extracted from the inpatient records and recorded on the data collection instrument, it was entered into an automated data base on Microstat, Version 4. A separate file was created for each of the four DRGs. Microstat, Version 4, was the statistical software used to analyze the data. Descriptive statistics were produced separately for each DRG. Any variables which had mean value of zero, and/or a standard deviation of zero, were omitted from the model for that DRG. Independent variables with these statistics had no differences in values among all cases and, therefore, would have no effect on the dependent variable. A compilation of the variables added and omitted from the basic model for each DRG is found in Table 9 below.

Table 9.

## Modifications to the Regression Model

Code	Variable Added	Variables Omitted
125	Emergency Admission	Preadmission Testing Long Term Care Facility
222	Pass	Sunday Admission Sunday Discharge Home Long Term Care Facility Acute Care Facility
359	Pass	Retiree Home Long Term Care Facility Acute Care Facility
373	Premature	Retiree Preadmission Testing Home Long Term Care Facility Acute Care Facility Radiological Tests

Full regression was performed on the data for each DRG to determine the accuracy of the full model followed by stepwise multiple regression analysis to determine which variables significantly contributed to length of stay. Relationships between some of the significant variables and other predictor variables were examined using correlation matrixes.

## Chapter II. FINDINGS

### DRG 125, Circulatory Disorders

The sample average length of stay for this DRG was 3.8 days with a standard deviation of 2.7963 as compared to the population mean and standard deviation of 4.22 and 3.43 days respectively. The sample range of length of stay was 1 to 16 days. The sample patient population consisted primarily of retirees (62%) followed by active duty (21%) and family members of retirees (14%). Family members of active duty servicemen and others combined represented only 3% of the patients. This distribution is expected since circulatory disorders are conditions which are normally found in older patients. The vast majority of patients (83%) were patients who were married and living with their spouse.

Patients were admitted more often on Tuesday or Wednesday; each representing 27% of admissions or a total of 54%. The remainder of admission days in descending order of frequency are Monday (19%), Thursday (12%), Friday (8%), Saturday (4%), and Sunday (3%). Discharges took place more often on Thursday, representing 29% of discharges, and Friday (25%). Fifteen percent of the cases were discharged on Wednesday followed by Saturday at

twelve percent. Tuesday, Monday, and Sunday accounted for 11, 7, and 1 percent of discharges respectively. This pattern of activity, with few admissions and discharges on the weekend days is expected since the majority of physician staff do not work these days.

There were three possible discharge destinations; home, a long term care facility, and another acute care facility. None of the patients were discharged to a long term care facility. Overwhelmingly, 81% of the patients were sent home after their inpatient episode. Nineteen of the patients, or 19%, were transferred to another acute care facility. These 19 were usually patients who had undergone the cardiac catheterization and required a Cardiac Artery Bypass Graft (CABG). The CABG procedure is not performed at MAMC which necessitates the transfer. Discharge planning was initiated, on an average, between the first and second day of admission (mean = 1.25).

An average of 67.69 laboratory procedures were performed per patient. The range was quite large with a minimum of 25 and a maximum of 267. Radiological procedures averaged 1.35, not including the procedures performed during the cardiac catheterization procedure. Consultations were minimal for this DRG. The average was 0.22 with a range from 0 to 2.

Thirty-three percent of the patients were emergency admissions. The remainder, 67%, were planned procedures. Surprisingly, no cases had any indication that preadmission testing was performed. A complete list of the descriptive statistics and the frequency distribution of length of stay for this DRG are at Appendix J.

The full regression model, as modified for this DRG, resulted in an  $r$  squared value of .6691 indicating that 66.9% of the variability was explained by all variables. As displayed earlier in Table 9, Emergency Admission was added as a variable while Preadmission Testing and discharge to a Long Term Care Facility were omitted. A stepwise regression was then performed using the modified version of the regression model. An  $F$  value of 4 was used to obtain a probability of .05 or less. The results of that regression are in Table 10. The adjusted  $r$  squared was used because it is a more conservative value than the unadjusted statistic.

Table 10.

## Regression Analysis, DRG 125

Variable	Regression Coefficient	Standard Error	F(1, 94)	Prob.	Partial $r^2$
Friday Admission	1.3326	.6281	4.501	.03650	.0457
Thurs. Discharge	-.9448	.3725	6.433	.01285	.0641
Discharge Planning	.4936	.1705	8.377	.00472	.0818
Laboratory Tests	.0383	.0042	81.179	.00000	.4634
Consults	.9303	.3433	7.342	.00801	.0724
Constant	.5546				

Standard Error of the Estimate = 1.6334

Adjusted  $r$  Squared = .6587

The variables found to be significantly associated with length of stay were Friday admissions, Thursday discharges, discharge planning, number of laboratory tests, and number of consults. The

regression coefficient indicates the change in length of stay for each per unit change in the dependent variable. For binary coded variables, it indicates the change in length of stay when that variable was coded as "1." The probability indicates the degree that the relationship between the dependent and independent variable occurs by chance. The partial r squared shows what portion of the variability in length of stay is explained by that variable while controlling for all other variables in the model. The adjusted r squared times 100 gives the percentage of variability explained by the model; in this case 65.87%.

Patients admitted on a Friday had an average length of stay 1.3326 days longer than other patients. The reason for this relationship is unknown. However, it can be hypothesized that it is a result of the reduced staffing on weekends and/or, since no preadmission testing is being done, that patients are admitted on Friday for testing prior to the cardiac catheterization on subsequent days. A correlation of discharge days of the week and Friday admissions revealed that there was a significant relationship between both Monday and Tuesday discharges and Friday admissions (Appendix K). While Friday admissions have longer lengths of stay, this variable alone explains only 4.57% of the variation in length of stay.

The only discharge day of interest was Thursday which was significantly associated with shorter lengths of stay. Patients discharged on Thursday spent approximately one day (.9448) less than other patients. A correlation was performed to determine on which days these patients were most likely to have been admitted (Appendix K). Both Tuesday and Wednesday were highly correlated

with Thursday discharges indicating possibly one or two day inpatient stays (the LOS range was 1 to 16 days). Referring back to the length of stay frequency distribution, 52% of the cases were 2 days long and only 4% were 1 day stays. Three of the four 1 day episodes were cases which were transferred to another acute care facility.

Discharge planning was another variable identified as being significantly associated with length of stay. For each day into the admission that discharge planning is initiated, length of stay increases an average of .4936 days.

The predictor variable which explained the most variability in length of stay for this DRG (46.34%) was laboratory tests. While it explains the most variability, it has the least absolute effect on length of stay. For each additional laboratory test performed, the length of stay increases .0383 days. It is expected that, for patients being treated for circulatory disorders, laboratory tests will be ordered each day to monitor their condition.

Consults were also significantly associated with increased lengths of stay. For each consult, length of stay was .9303 days longer. This can be a reflection of a case where the patient has other medical problems which must be resolved and/or where consults are not being done in a timely manner. Overall, the number of consults, while controlling for other variables, explains about 7% of the variability in length of stay.

The model, as applied to DRG 125, accounts for 65.87% of the differences in length of stay among patients. There is still approximately 34% of the variability which is associated with other variables not considered here.

## DRG 222, Knee Procedures

DRG 222 had a sample mean length of 4.14 days with a standard deviation of 2.3996 days. This is less than the population mean of 5.29 days (with a standard deviation of 6.1 days). This disparity may be attributable to the adjustment of some sample lengths of stay for convalescent leave days. The range of stays were 1 to 11 days. The frequency distribution of the lengths of stay show that the sample is not normally distributed (Appendix L).

Seventy-nine percent of the patients having knee procedures were active duty. Family members of active duty service-people represented 13% of the cases and family members of retirees were 4%. Retirees made up only 3% of the patients and the remaining 1% were others. Clearly, over half of the patients (56%) were married and living with their spouse, 35% were single, and 9% were in the "Other" category, e.g., married not living with spouse and child living with parent.

None of the sample patients were either admitted or discharged on a Sunday. Forty percent had been admitted on a Monday while another 31% were admitted on Thursday. The percentage of patients admitted on other days decreases by a factor of 0.5 beginning with Wednesday (16%), Friday (8%), Tuesday (4%) and ends with only 1% for Saturday admissions. Discharges occurred most frequently on Wednesday (34%) and Monday (25%). Fifteen percent of the patients ended their hospitalization on a Friday. Both Thursday and Saturday had 9% of the discharges and Tuesday had 8%.

Regardless of the day discharged, all patients were discharged home/to duty. No patients were sent to another acute care or long

term care facility. This finding is expected given the high percentage of active duty patients and the relative minor severity of this type of surgery. Similar to the previous DRG, the discharge planning activities normally began between the first and second day of hospitalization (mean = 1.31).

Only 4% of the cases used preadmission testing. This finding was unexpected since most knee procedures are planned surgeries.

An average of 28.14 laboratory procedures were performed per case with a range of 0 to 100. The lower extreme is represented by one day stay where all testing was performed prior to admission. The high extreme with 100 laboratory tests is also the case with highest length of stay (11 days). Radiological procedures averaged .63 and consults averaged 1.28 per patient. Most patients received a consult to Physical Therapy for instruction in rehabilitative exercises and use of crutches.

Knee procedure patients averaged .45 days on pass in conjunction with either the day of admission or the day of discharge. This practice artificially extends the length of stay, the implications of which are addressed later. A complete list of descriptive statistics are at Appendix L.

The full regression model resulted in an explanation of 53.15% of the variability in the dependent variable; length of stay. The data for DRG 222 was subjected to stepwise regression analysis to determine significant predictor variables. The results of the analysis are presented in Table 11. Two variables were significantly associated with shorter lengths of stay and four with longer lengths of stay. All probabilities were well below the .05 level.

Table 11.

## Regression Analysis, DRG 222

Variable	Regression Coefficient	Standard Error	F(1, 93)	Prob.	Partial r <sup>2</sup>
Family of Retiree	-2.0664	.9053	5.210	.02473	.0531
Monday Admission	-1.0912	.3401	10.297	.00183	.0997
Monday Discharge	1.1924	.3867	9.507	.00269	.0927
Discharge Planning	.5841	.1364	18.333	.00005	.1647
Laboratory Tests	.1308	.0161	66.204	.00000	.4158
Radiological Proc.	.6135	.1619	14.358	.00027	.1337
Constant	-.4702				

Standard Error of the Estimate = 1.6183

Adjusted r Squared = .5452

Patients who were family members of retirees tended to have a 2.0664 day shorter length of stay. These patients only represent 4% of the patient population for this sample and explain 5.31% of the variability in length of stay.

Monday admissions were also associated with shorter lengths of stay. These cases averaged 1.0912 days less. Correlation was used to determine the days of discharge associated with Monday admissions (Appendix M). The strongest correlation was with Wednesday admissions, however, there were significant correlations with Friday and Saturday as well.

Converse to Monday admissions, Monday discharges were significantly associated with longer lengths of stay. This variable accounts for approximately 10% of length of stay differences. When correlated with days of admission, Thursday was

the only one to have a significant correlation. The Thursday to Monday hospitalizations are included in the peak at the 4 day position on the length of stay frequency distribution. This also adds support to the hypothesis that less care is delivered on the weekends due to reduced staffing.

Discharge planning was associated with length of stay as it was in the previous DRG. Length of stay increases an average of .5841 days for each day that discharge planning is delayed. The probability of this relationship occurring by chance alone is .00005; far below the level of significance. Discharge planning accounts for 16.47% of the length of stay variability when controlling for other variables in the regression equation.

Laboratory tests were again found to explain the greatest percent of variability (41.58%). For each additional laboratory test performed, length of stay increased an average of .1308 days. Assuming longer lengths of stay represent more difficult cases, additional tests would be necessary to properly assess the patient.

The last variable which is significantly associated with length of stay for DRG 222 is radiological procedures. The hospital stay increases by .6135 days for each procedure. Invoking the previous assumption concerning length of stay and difficulty of cases, one would expect that additional x-rays would be required to assess the extent of knee damage and the results of surgery.

The adjusted  $r$  squared for the equation was .5452 indicating that the model can explain approximately 54.5% of the variability

in the dependent variable. Nearly half of the variability is unexplained by the predictors in the regression model.

#### DRG 359, Uterus and Adnexa Procedures

The sample mean for DRG 359 was 6.16 days with a standard deviation of 2.2144 days. The length of stay range began at 1 day and extended to 12 days. This sample is representative of the population which had a mean of 6.42 days.

Family members of active duty servicemen represented 56% of the patients in the sample. Active duty servicewomen were the next largest group at 24%. Seventeen percent of the hospitalizations were for family members of retirees and 3% for others. There were no retirees in the sample. The vast majority of patients (82%) were married.

Thirty-seven percent of the patients were admitted on Friday for this procedure. Wednesday and Thursday were tied as the next most frequently occurring admission day with 22% each. Eleven percent of the admissions occurred on Monday and 4% on Tuesday. The remaining 4% of the patients were admitted either on Sunday (2%) or Saturday (2%). Sixty-eight percent of the patients had tests performed prior to admission.

Discharges were fairly evenly distributed throughout the week. Monday, Thursday, and Friday had 18% of the discharges each. Saturday, Tuesday, and Wednesday had 15%, 14%, and 11% of the discharges respectively. Only 6% of the patients in the sample were discharged on Sunday. All patients were discharged home/to duty.

Discharge planning was generally initiated on the first day of the admission (mean = 1.06). The range was from the first day of admission to the third day of admission indicating timely discharge planning.

The average sample case had 54.89 laboratory tests which ranged from 7 to 144. The wide range of tests is expected given the range of length of stay. Radiological procedures averaged .53 per case with some patients receiving none and some as many as four. Consults were seldom used. The average number of consults per case was .22 with a range of 0 to 2.

The use of passes in conjunction with the day of admission and/or the day of discharge averaged out to .81 pass days per patient. The least amount of pass days for a given case was 0 days and the maximum was 7 days. Appendix N lists all descriptive statistics for this DRG.

A total of 43.9% of the differences in length of stay were explained by the predictor variables in the full regression model. The stepwise regression performed on the data revealed that 5 of the variables were significantly associated with length of stay (Table 12). As with DRG 125, Friday admissions had longer lengths of stay; an average of 1.1519 days. The partial r squared indicated that 8% of the variability in length of stay is explained by this variable while controlling for all others.

Two discharge days were significantly associated with shorter lengths of stay; Sunday and Thursday. The length of stay for cases with a Sunday discharge averaged 1.4 days less than the sample mean and Monday discharges were about 1.6 days less. Since day of discharge alone hold little meaning, correlation matrixes

were used to examine the relationships between the days of admission and the two discharge days to determine when the patients were being admitted (Appendix O). There was a high correlation between Wednesday admissions and Sunday discharges. Thursday discharges were significantly correlated with three admission days; Saturday, Thursday, and Friday.

Laboratory procedures were again found to be significantly associated with length of stay. For every additional laboratory test performed, length of stay increased an average of .0284 days. This predictor variable accounts for about 16% of the variation in length of stay when controlling for the other variables in the equation. This is less than half of the variation it explained in the previous two DRGs.

Table 12.

Regression Analysis, DRG 359

Variable	Regression Coefficient	Standard Error	F(1, 94)	Prob.	Partial r <sup>2</sup>
Friday Admission	1.1519	.4024	8.197	.00517	.0802
Sunday Discharge	-1.4192	.6895	4.237	.04232	.0431
Thursday Discharge	-1.5990	.4521	12.510	.00063	.1175
Laboratory Tests	.0248	.0059	17.864	.00005	.1597
Pass	.6954	.1312	28.098	.00000	.2301
Constant	4.1811				

Standard Error of the Estimate = 1.6219

Adjusted r Squared = 46.36

The variable which had the highest partial  $r$  squared (.2301) for this regression was "pass." The use of passes in conjunction with the admission and/or discharge days explained the greatest percentage of variability in length of stay. The probability of this relationship occurring by chance was so low that it was computed at the .00000 level. Several correlations were performed to determine if there was a significant relationship between passes and marital status, patient category, or day of admission (Appendix O). There were no significant correlations between pass and marital status. There was a significant relationship between "active duty" and pass indicating that active duty patients were more likely to be placed on pass than other categories of patients. Three admission days (Monday, Wednesday, and Friday) had significant correlations with "pass." Friday had the highest correlation.

The adjusted  $r$  squared was only .4636 indicating that the regression model can explain less than 50% of the differences in length of stay for these cases. There are other variables not identified which contribute to the balance of the variation.

#### DRG 373, Vaginal Delivery

DRG 373 had a sample mean length of stay of 3.13 which approximates very closely the population mean of 3.15 days. The sample standard deviation was approximately half of that of the population (1.16 versus 3.0). The sample length of stay distribution is skewed to the right and not normally distributed (Appendix P).

The majority of patients (82%) were family members of active duty servicemen. Active duty servicewomen accounted for 13% of the patient sample. Three percent of the patients were family members of retirees and two percent were categorized as "other." Almost all patients (93%) were married and living with their spouse.

Patients were admitted to the hospital on Fridays 21% of the time. The next most frequently occurring admission day was Saturday with 18% of admissions. Other admission days in descending order were Thursday (16%), Monday (14%), Wednesday (13%), Sunday (11%), and Tuesday (7%). Discharges occurred most frequently on Tuesdays (20%) and were distributed relatively equal across the other days of the week, except Saturday (9%). Discharge planning usually began on the first day of hospitalization (mean = 1.02).

Data on preadmission testing was not collected for two reasons. First, the concept of preadmission testing was not applicable to vaginal deliveries. Second, all patient records had evidence of prenatal care in their inpatient records which, if considered preadmission testing and coded as such, would have negated any effect on length of stay.

All patients were discharged home upon completion of their inpatient stay. This is expected for vaginal deliveries without complicating diagnoses.

Ancillary services used during these hospitalizations included laboratory tests (mean = 43.45) and an occasional consult (mean = .10). The absence of any radiological procedures is expected.

As mentioned earlier, "prematurity" was added as a DRG 373-specific variable which might impact on length of stay. Five percent of the cases in the sample involved premature delivery. A complete list of the descriptive statistics is at Appendix P.

When all variables in the full model were regressed against length of stay, the  $r$  squared value was .2343 (23.43% explained variability). Stepwise regression, when applied to the sample data, showed that active duty patients, Monday admissions, discharge planning, laboratory tests, and premature delivery were significantly associated with longer lengths of stay (see Table 13). No variables were found to be significantly associated with shorter lengths of stay. Active duty patients had an average length of stay approximately 1.2 days longer than the sample mean length of stay. This category of patient accounted for 13.72% of the variability in the dependent variable when controlling for all other predictors in the model.

Patients admitted on Monday had an average of .75 more days in the hospital. However, the day of admission in delivery cases is normally out of the control of the patient and the healthcare provider.

Length of stay increased an average of 1.68 days for each one unit change in discharge planning. Laboratory tests also increased the average stay by .0132 days for each additional test. Finally, cases where the child was delivered prematurely had an average of .5103 additional hospital days. This last finding can be explained by increased complexity of premature deliveries.

This model explained only 20% of the variability in length of stay for this DRG (adjusted r squared = .2009). A much higher adjusted r squared is desirable.

Table 13.

## Regression Analysis, DRG 373

Variable	Regression Coefficient	Standard Error	F(1, 94)	Prob.	Partial r <sup>2</sup>
Active Duty	1.2196	.3155	14.947	.00020	.1372
Monday Admission	.7506	.3022	6.170	.01476	.0616
Discharge Planning	1.6849	.7440	5.128	.02584	.0517
Laboratory Tests	.0132	.0062	4.549	.03554	.0462
Premature	1.2878	.4819	7.140	.00889	.0706
Constant	.5103				

Standard Error of the Estimate = 1.0373

Adjusted r Squared = .2009

## Chapter III. DISCUSSION

## Significant Variables

Thirteen predictor variables were found to be significantly associated with length of stay. Some of these were significant for a single DRG while the significance of others was present in multiple DRGs. Table 14 lists all significant independent variables by DRG and indicates if the variable was associated with longer or shorter lengths of stay.

Table 14.

## Significant Variables

	DRG 125	DRG 222	DRG 359	DRG 373
Active Duty				+
Family Member of Retiree		-		
Monday Admission		-		+
Friday Admission	+		+	
Sunday Discharge			-	
Monday Discharge		+		
Thursday Discharge	-		-	
Discharge Planning	+	+		+
Laboratory Tests	+	+	+	+
Radiological Procedures		+		
Consultations	+			
Pass			+	
Premature Delivery				+

(-) significantly associated with shorter LOS

(+) significantly associated with longer LOS

Patient category was only significant for two of the DRGs. Active duty servicewomen had longer lengths of stay when admitted for vaginal delivery. In the absence of other factors, this finding tends to support the belief that active duty patients are treated (administratively) different for this type of case than other patients. Family members of retirees had shorter lengths of stay when admitted to MAMC for knee surgery. Although there was a statistically significant relationship between this latter

category of patient and length of stay, they represented only 4% of the cases and no hypothesis can be offered to explain this phenomenon.

Day of admission was significant for all four of the DRGs studied. This result is inconsistent with the findings of the study performed by Marchette and Holloman (1986). Monday was significantly associated with shorter lengths of stay for circulatory disorders with cardiac catheterization and associated with longer lengths of stay for vaginal delivery. The former can possibly be attributed to planned surgeries; when correlating Monday admission with emergency admissions the critical value was not met. Monday admissions being associated with longer lengths of stay for deliveries evades explanation.

The other day found to be associated with longer lengths of stay was Friday. This relationship was present for both circulatory disorders (DRG 125) and uterus and adnexa procedures (DRG 359). This can be explained two ways. First, as mentioned earlier, there is less staff in the hospital during the weekend and less care is probably delivered. Second, particularly for DRG 359, patients are admitted on Friday and placed on pass the same day. The relationship between passes and Friday admissions was demonstrated in the correlation analysis for DRG 359.

Several discharge days were also significantly associated with the dependent variable; another finding inconsistent with the Marchette and Holloman study (1986). Sunday was associated with shorter lengths of stay for DRG 359, Monday was associated with longer lengths of stay for DRG 222 (knee procedures) and Thursday discharges averaged shorter hospital stays for DRGs 125 and 359.

When analyzing Sunday as a day of discharge for DRG 359, the single admission day which highly correlates is Wednesday. A Wednesday to Sunday admission encompasses part of the weekend; the time hypothesized as having less staff and, therefore, decreased productivity. The relationship between Sunday discharges and decreased length of stay for DRG 359 cannot be explained. This also holds true for Thursday discharges in DRG 359. The admission with the highest correlation with Thursday discharges is Friday, which would include both days of the weekend.

Monday discharges in DRG 222 were associated with longer lengths of stay and highly correlated with Thursday admissions. This tends to support the reduced weekend staff and productivity theory.

There was a very high correlation (.70339) between Thursday discharges and Tuesday admissions for DRG 125. Since Thursday discharges were associated with shorter lengths of stay and the average length of stay is 3.8 days, it can be concluded that these are short two-day admissions. These Tuesday-Thursday hospitalizations are probably the routine planned cases.

Three of the DRGs had discharge planning as a significant variable. While statistically this was significant, the average time to initiate length of stay and the frequency distributions at Appendix R show that, overwhelmingly, discharge planning activities began on the first day of admission.

Laboratory tests were significantly associated with length of stay for all DRGs. As the average number of laboratory tests increase, so does length of stay. This can be attributed to the fact that most patients require additional laboratory tests each

day they are in the hospital. What is not reflected in the statistics is how much of the testing could be done prior to admission. DRG 125 (circulatory disorders with cardiac catheterization) had no preadmission testing even though only 33% of the cases were emergency admissions. Similarly, DRG 222 (knee procedures) did not use preadmission testing in 96% of the cases.

Radiological procedures were significantly associated with length of stay only for knee procedures. X-rays were used both as a diagnostic tool and for verifying results of surgery. It is possible that some of the diagnostic procedures could be performed on an outpatient basis as part of preadmission testing. Forty percent of the cases had a length of stay of 2 days. With preadmission testing, these two-day stays could possibly be reduced to one-day hospitalizations or even be candidates for same day surgery.

Consistent with the findings of Jones (1985), the number of consults was significant; but only for DRG 125. This finding may be a reflection of more severe cases which require additional time in the hospital and expertise of other disciplines. However, consults are often used for additional assessment of the patient's condition and, given the case is not an emergency admission, could be candidates for preadmission work-ups.

The use of passes in conjunction with the day of admission and/or day of discharge as a significant predictor of length of stay was expected. It was not expected to be significant for only one DRG (359). This additional variable was added because, during the data collection, it appeared to be a common practice in two of the DRGs. This suspicion was substantiated for uterus and adnexa

procedures by the result that it was the single best predictor of length of stay.

There are several possible explanations for this practice. First, patients are admitted on Friday, have pre-surgery testing performed, and are placed on pass until Sunday for a Monday procedure. As was reported earlier, Friday correlated higher with pass than any other admission day. Second, this practice ensures that the patient will have a bed available to them for the scheduled surgery. Third, it may be a matter of convenience to the physician. For example, a patient may be ready for discharge on a Friday but the physician would rather postpone doing the paperwork until Monday. He/she, therefore, places the patient on pass.

There was also high correlation between passes and active duty patients. Why active duty patients would be more likely to be placed on pass at either the beginning or end of their hospitalization is unknown. The correlation does reinforce the idea that the active duty patient sometimes has unique requirements.

The practice of using pass days is not entirely irrational under the MCCU system. Each pass day is included in the length of stay and additional resources are received while none are being used. It does not, however, maximize the utilization of available beds. Under a DRG based resource allocation system, artificially longer lengths of stay could impact on resourcing since it would appear that the facility was not efficient.

The last variable found to be significantly associated with length of stay was premature delivery. This is obviously a

DRG-specific variable for vaginal delivery. The finding was expected to explain, in part, some of the variability in length of stay.

### Variables not Significant

There are several predictor variables in the model that were not found to be significant for any of the DRGs studied. These were marital status, preadmission testing, discharge destination, and emergency admissions.

The finding that marital status was not associated with length of stay was unexpected and is inconsistent with the findings of Jones (1985). It also undermines the theory that a significant portion of the single patient population, particularly active duty patients, are kept in the hospital longer for lack of support systems.

The fact that preadmission testing was not significant was also unexpected in light of the experience of the civilian health care community (Munoz et al 1986). This can be easily explained for three of the DRGs. No preadmission testing was done for circulatory disorders with cardiac catheterization, only 4% of the knee procedure cases involved preadmission testing, and the variable was found to be inappropriate for vaginal delivery and, therefore, not included. Sixty-eight percent of uterus and adnexa procedure cases did have preadmission testing done but it did not reduce their average length of stay. The reason for its failure to impact on length of stay is unknown. It was noted during the data collection phase that some patients received preadmission testing but were still placed on pass in conjunction with their

day of admission which negates the possible reduction in the length of stay statistic.

Contrary to the findings in the study by Marchette and Holloman (1986), discharge destination did not impact on length of stay in any of the four DRGs. The lack of significance in DRGs 222, 359, and 373 is due to the fact that all of the patients were discharged home/to duty and, therefore, the discharge destination has no effect on the dependent variable. Patients in DRG 125 had two discharge destinations. Eighty-one percent were sent home and the other 19% were transferred to another acute care facility, but no significant difference in average length of hospitalization occurred.

Emergency admissions for circulatory disorders were hypothesized to have a higher severity of illness, require more care, and, therefore, be a predictor of length of stay. The results of the regression showed that this hypothesis had to be rejected.

#### Controllable versus Uncontrollable Variables

Variables which have been identified as significantly associated with length of stay can be classified as either controllable or uncontrollable. A controllable variable is defined here as one which can be directly affected by the healthcare provider. By classifying the variables this way, methods of regulating the variables can be developed to achieve decreased lengths of stay and cost per case.

The category in which a patient is classified, e.g., active duty or family member, is certainly not determined by the

provider. The mix of patients admitted to the hospital could be, and many times is, controlled by the physician, but, for reasons other than trying to achieve shorter lengths of stay. For example, priority of services go to active duty soldiers and their families, thereby, reducing the availability of inpatient beds to retirees. What is controllable is whether or not active duty soldiers are managed as patients differently than other patients as some of the findings suggest.

Admission and discharge days are determined by the physician with some limitations. To be admitted the hospital must possess the capability to treat the patient's condition, there must be a bed available in which to place the patient, and sufficient staffing must be available to care for him. The patient's discharge is dependent on him being well enough to leave the hospital (a condition judged by the physician). Outside of these constraints, the physician is the determinant of when the patient enters or leaves the hospital.

Discharge planning is the responsibility of the entire health care team. Any of the health care providers (physician, nurse, etc.) can help assess the patients needs and identify possible discharge problems. This function is normally performed by the nursing staff. The time at which discharge planning is initiated is within the control of a health care provider. What may be beyond the provider's control is the fulfillment of the discharge need, e.g., a bed in a long term care facility.

The physician is the person who orders laboratory tests for his patients and, therefore, controls this variable. Few restrictions are placed on the numbers and types of tests.

Protocol for a given condition will determine a minimal standard, but, the physician's judgement is used thereafter. The other aspect of laboratory tests which is within the physician's control is the setting in which some tests are performed, i.e., either on an inpatient basis or an outpatient basis as part of preadmission testing.

The number of radiological procedures are also determined by the attending physician. They are used in the diagnosis of the patient and in assessment of treatment effectiveness. When used as a diagnostic tool, these procedures can sometimes be performed on an outpatient basis prior to admission, or as part of the inpatient stay, at the discretion of the health care provider.

Consults are usually dictated by the patient's condition. A patient's course of treatment for his acute condition may be dependent upon an existing chronic medical problem which requires the input of another specialty. In other cases, such as knee procedures, consults are used for pre- and post-operative teaching from Physical Therapy. Physicians can, in some instances, designate if a consult will be performed on an inpatient or outpatient basis.

The use of passes, in this case in conjunction with the day of admission and/or day of discharge, is the decision of the physician. A patient cannot be placed on pass without a physician order. The tendency of the physicians who treated the sample patients in DRG 359 was to give more passes to active duty patients and send patients out on pass on Fridays. This variable is the most controllable of all the predictor variables.

The last significant predictor is premature delivery. While drugs exist to alter the timing of deliveries, this variable is considered uncontrollable for the purposes of this study. All other significant independent variables, or some aspect of them, are controllable and, therefore, can be managed to achieve shorter lengths of stay.

#### Chapter IV. CONCLUSIONS AND RECOMMENDATIONS

##### Conclusions

The first conclusion is that Madigan's lengths of stay are comparable, and in some cases better, than those at University Hospital. MAMC had a significantly longer length of stay in only 6 of its top 25 occurring DRGs when compared to its civilian counterpart. There were two DRGs where both the average age and case mix index was greater at Madigan while the length of stay was significantly shorter. However, this does not lead to a subsequent conclusion that additional reductions in length of stay and improved economy is not warranted nor desirable.

There is evidence in the results of this study, even given their limited generalizable nature, that there are opportunities to improve. The physicians represented in this study are practicing medicine with a MCCU based resource allocation system mind set. This observation is made not as a criticism but as a statement of fact. This orientation is currently justified since 95% of resources are still being distributed based on MCCUs and only 5% on DRGs. A transition must be made in the near future to practice with a DRG based resource system philosophy.

The issue of preadmission testing provides a prime example of where Madigan physicians are in terms of MCCUs versus DRGs. Preadmission testing is not being performed to the extent possible. Not performing diagnostic testing prior to admission, when possible, is unthinkable in a DRG environment. Certainly, of the 100 knee procedure cases examined in this study, some must have been candidates for preadmission testing. The same is true for cases admitted for circulatory disorders with cardiac catheterization. A typical two-day length of stay, e.g., admitted on Tuesday and discharged on Thursday, for a scheduled procedure began with testing on the day of admission, cardiac catheterization on the next day, and discharge on the final day. The use of preadmission testing could reduce the length of stay by one day.

Passes appear to be abused in DRG 359. The fact that almost every patient had a pass day (mean = .81) in conjunction with the day of admission or discharge and that it explained 23% of the variation in length of stay supports this conclusion. As stated before, this pays off under MCCUs but can be detrimental under a DRG based resource allocation system.

Some of the data indicates that there are cases which are currently being done on an inpatient basis which could be performed in a same-day or an ambulatory surgery setting. For example, there was no comparative length of stay at University Hospital for DRG 351, male sterilization. These procedures are not performed there on an inpatient basis. There were also a large number of 2 day stays (40%) for knee procedures which might be candidates for surgery in an alternative setting.

There was not sufficient evidence to support the hypothesis that single, active duty patients have either significantly longer or shorter lengths of stay as compared to other patients. The results did indicate that, for uterus and adnexa procedures, active duty patients are managed differently.

The restricted regression model resulting from the stepwise regression was only one percentage point less accurate than the full model. The model, as adapted for each DRG, was reasonably accurate for DRGs 125 and 222, less accurate for DRG 359, and a poor predictor for DRG 373. This does not jeopardize the validity of the findings reported but indicates that there are other factors not considered here effecting length of stay.

### Recommendations

The Congressional mandate to use a DRG based allocation system is not likely to be rescinded in a time of constrained resources. Positioning MAMC to be competitive in a DRG environment is prudent management. In that light, efforts should be made to shift the emphasis in practice from the traditional MCCU orientation to DRGs. While the majority of resources are still being allocated based on MCCU workload, the DRG based allocation system will rely on the previous year's performance to determine the current year's budget. Therefore, improving the DRG posture now will be rewarded in the future.

The key to decreased lengths of stay is individual physicians. It is their admitting, discharge, and ordering practices which can alter the length of hospitalization. Changing current practice patterns to those which will benefit the hospital is dependent

upon education and policy. The concept of educating staff on DRGs is not a new recommendation. The use of education in adapting to DRGs was suggested in a report from the Triservice Performance Measurement Group which was distributed to U.S. Army hospital and medical center commanders in November 1987. The MAMC DRG Committee should be tasked to develop and implement a training program directed at physicians.

Education alone will not change behavior, it only provides the reason for change. The command should develop policies which reinforce the principles of practicing medicine in a DRG environment, i.e., containing costs through reduced lengths of stay and efficient utilization of resources. Such policies must address the controllable variables which have been identified as significantly associated with length of stay, e.g., eliminating use of pass days at the beginning or end of a hospital stay.

Physicians should be encouraged to use preadmission testing when possible. This includes laboratory tests, radiological procedures, and consults. An increase in preadmission testing would result in shorter lengths of stay and decreased costs as demonstrated by Munoz et al (1986). To assist the physicians in this effort, consideration should be given to establishing standard procedures for scheduling preadmission tests and compiling the results so they will be available at the time of admission. In addition to moving testing into the appropriate setting, utilization of tests should be reviewed.

Physicians should also be encouraged to use more same-day and ambulatory surgery. In addition to the cases sited earlier as potential ambulatory surgery cases, there are probably other

procedures currently being performed on an inpatient basis that could be performed in this setting.

There are further studies which should be performed to identify additional variables which contribute to length of stay. Two of the DRGs not studied here were DRG 390 (neonates with other significant problems) and DRG 391 (newborns). Both of these are high frequency DRGs which totaled 2160 cases in FY 88. Each had a significantly longer length of stay and lower case mix index when compared to University Hospital. The neonatal cases are not only high frequency (1164), but also high cost. Because of the resources required to treat neonates, an attempt should be made to determine if length of stay can be reduced.

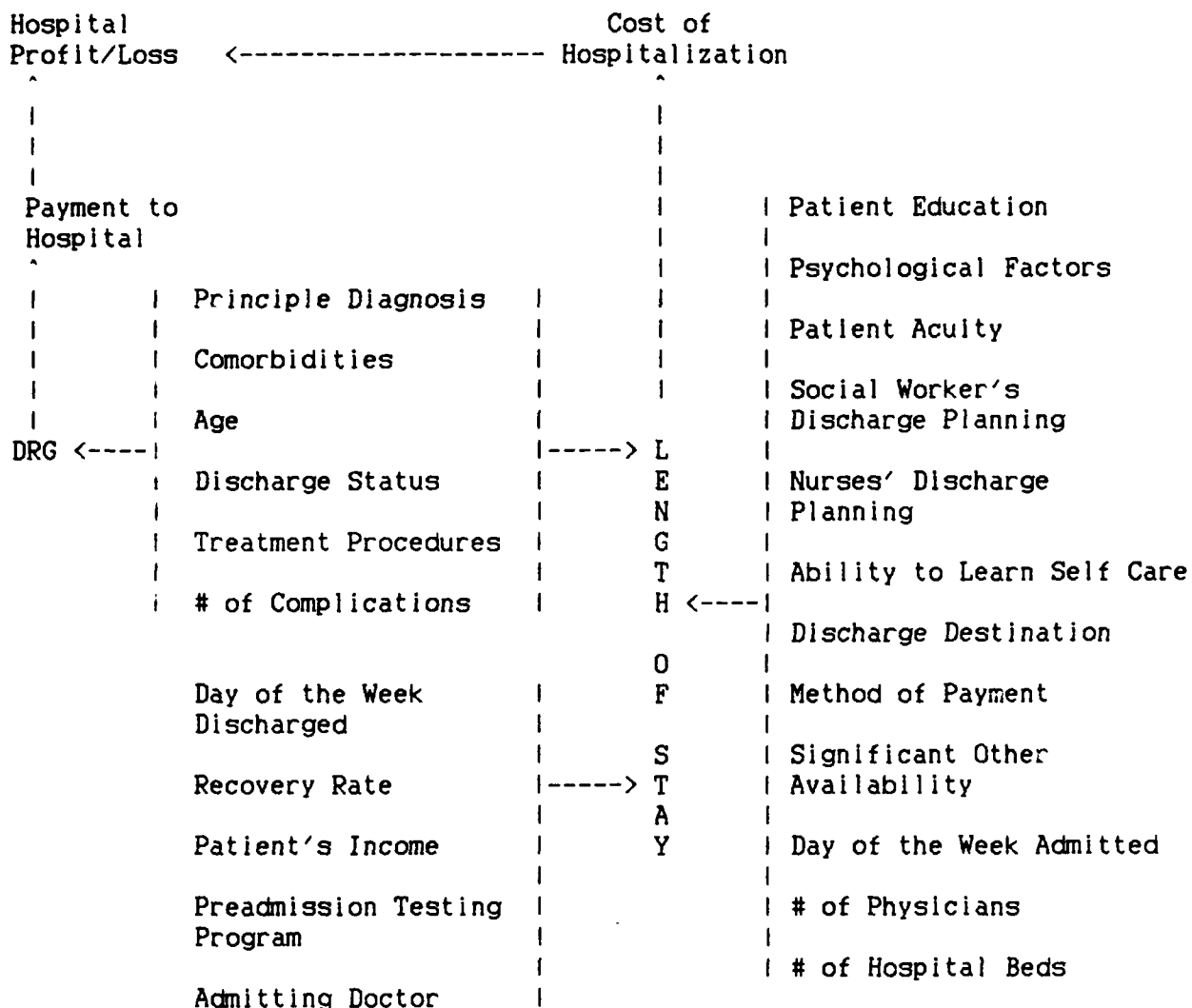
Not all of the variability in length of stay for the DRGs studied was explained by the predictors in the regression model. Additional investigation into variables contributing to length of stay at MAMC is warranted.

Finally, efforts should be made to determine if the active duty patient has different requirements than other patients. The fact that they had a longer length of stay for one DRG and were more likely to be placed on pass may be an indicator of unique needs. If this is true, these requirements should be identified and addressed.

Until new systems are developed which can provide accurate and timely cost data for individual patients or DRGs, the best place to begin reducing costs of inpatient care is reducing length of

stay. This study has identified some of the variables which contribute to length of stay at Madigan Army Medical Center and proposed actions which should result in reduced lengths of stay and decreased costs.

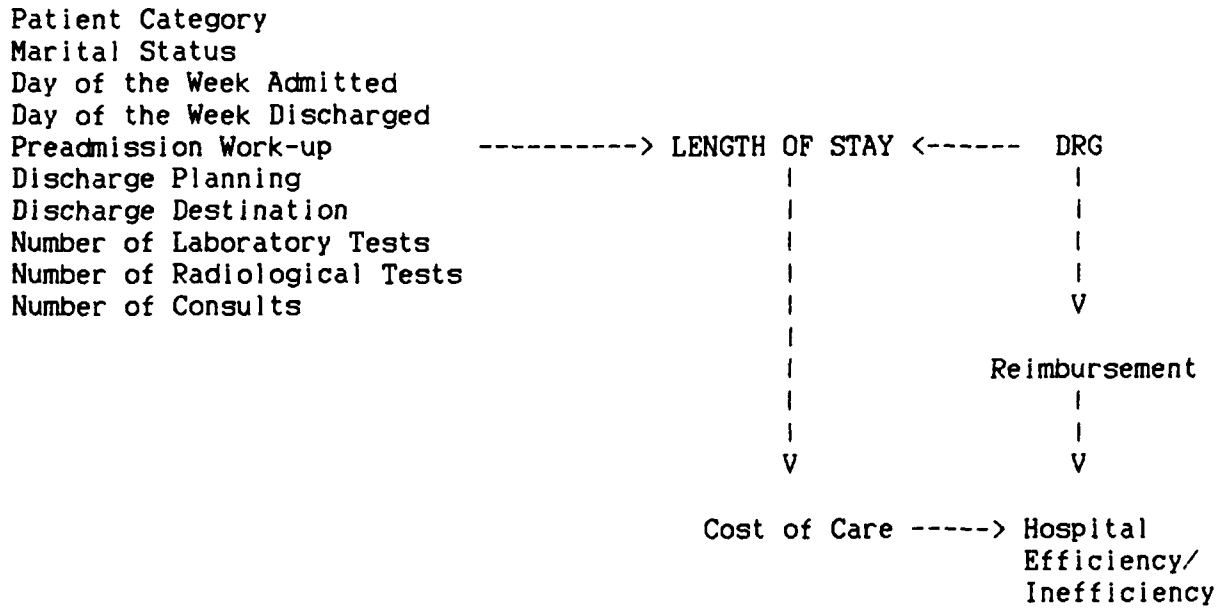
Appendix A. Diagram of Marchette and Holloman Length of Stay Conceptual Framework



"REPRODUCED AT GOVERNMENT EXPENSE"

Adapted from Figure 1, Marchette, L. and F. Holloman, "Length of Stay: Significant Variables." Journal of Nursing Administration 1986 March; 16(3): 12-20.

Appendix B. Conceptual Framework for Length of Stay at Madigan Army Medical Center



## Appendix C. Coding of Variables for Regression Model

<u>Variable</u>	<u>Description of Coding</u>	<u># of Coded Variables</u>
<b>Dependent Variable</b>		
Length of Stay	Code # of hospital days	1
<b>Independent Variables</b>		
Patient Category	Code 1 or 0 for: Active Duty Family Member of Active Duty Retiree Family Member of Retiree Other	5
Marital Status	Code 1 or 0 for: Married living with spouse Single (includes divorcees) Other	3
Day of the week admitted	Code 1 or 0 for each day of the week	7
Day of the week discharged	Code 1 or 0 for each day of the week	7
Preadmission Work-up	Code 1 for Yes, 0 for No	1
Discharge Planning	Code # of hospital day when initiated	1
Discharge Destination	Code 1 or 0 for: Discharge to home/duty Transferred to LTC facility Transferred to another acute care facility	3
Number of laboratory tests	Code number of tests performed during inpatient stay	1
Number of radiological tests	Code number of tests performed during inpatient stay	1
Number of consults	Code number of consults performed during inpatient stay	1

Number of Dependent Variables = 1

Number of Linearly Independent Predictor Variables = 30

## Appendix D. Characteristics and Capabilities of MAMC and Candidate Facilities

	MAMC	UNIV	SWED	HARBOR	PROVID
Operating Beds	402	381	597	312	376
Average Census	286	296	443	277	250
AVAILABLE SERVICES					
Alcho/Chem Depend Outpnt	1			1	1
Alcho/Chem Depend Unit					
Ambulatory Surgery	1	1	1	1	1
Birthing Room	1		1		1
Blood Bank	1	1		1	1
Burn Care Unit				1	
Cardiac Cath Lab	1	1	1		1
CT Scanner	1	1	1	1	1
Day Hospital			1	1	
Diagnostic Radioisotope	1	1	1	1	1
Emergency Department	1	1	1	1	1
Family Planning	1	1	1	1	
Genetic Counseling	1		1		
Geriatric	1		1	1	
Health Promotion	1		1	1	1
Hemodialysis	1	1	1		1
Histopathology Lab	1	1	1	1	1
Home Care Program	1		1		
Hospice			1		
Hospital Auxiliary	1		1	1	1
ICU (Mixed or Other)	1	1	1	1	1
ICU(Cardiac Care Only)	1		1		1
Megavoltage Rad Therapy	1	1	1		1
MRI		1			1
Neonatal ICU	1	1	1		
Obstetrics	1	1	1		
Occupational Therapy	1	1	1	1	1
Open Heart Surgery		1	1		1
Organ Transplant		1	1		
Organized Outpatient Dpt	1	1	1	1	1
Patient Representative	1	1	1	1	1
Pediatric Inpatient Unit	1				
Physical Therapy	1	1	1	1	1
Psych Consult-Liaison	1			1	
Psych Partial Hosp Prog				1	1
Psychiatric Education				1	
Psychiatric Emergency	1			1	1
Psychiatric Inpatient	1	1		1	1
Psychiatric Outpatient	1			1	
Radioactive Implants	1	1	1		1
Recreational Therapy				1	1
Rehab Inpatient Unit		1		1	
Rehab Outpatient	1	1	1	1	1
Respiratory Therapy	1	1	1	1	1
Speech Pathology	1	1	1	1	1

"REPRODUCED AT GOVERNMENT EXPENSE"

Appendix D. Characteristics and Capabilities of MAMC and Candidate Facilities  
(Continued)

	MAMC	UNIV	SWED	HARBOR	PROVID
Therapeutic Radioisotope	1	1	1		1
Trauma Center	1		1	1	1
Ultrasound	1	1	1	1	1
Volunteer Services Dept	1	1	1	1	1
Women's Center		1		1	
X-ray Radiation Therapy	1	1	1		1
No. Services the Same as MAMC		26	32	26	30

## Appendix E. Teaching Programs at MAMC and Candidate Facilities

Teaching Programs	MAMC	UNIV	SWED	HARBOR	PROVID
Allergy/Immunology		1		1	
Anesthesia		1		1	
Child Psychology	1	1			
Dermatology		1			
Developmental Peds	1				
Emergency Medicine	1				
Endocrinology	1	1			
Facul Devel Research	1				
Family Practice	1	1	1		1
Gastroenterology		1			
Hematology/Oncology	1	1			
IM/Cardiovascular Di		1			
Infectious Diseases		1			
Internal Medicine	1	1	1	1	1
Maternal/Fetal Med	1				
Neonatal/Perinatal		1			
Nephrology		1			
Neuro Pathology		1			
Neuro Psychology	1				
Neuro Surgery		1		1	
Neurology		1		1	
Nuclear Medicine		1		1	
Ob/Gyn	1	1	1	1	
Ophthalmology		1		1	
Orthopaedics	1	1	1	1	
Otolaryngology	1	1			
Pathology	1	1	1	1	1
Pediatrics	1	1			
Psychiatry		1		1	
Public Health	1				
Pulmonary Disease	1	1			
Radiologic Oncology		1			
Radiology		1	1	1	
Rehabilitation		1		1	
Rheumatology		1			
Surgery	1				
Thoracic Surgery		1		1	
Transitional	1				
Urology	1	1		1	
Vascular Surgery		1		1	
Number of Teaching Programs the Same as MAMC		12	5	5	3

"REPRODUCED AT GOVERNMENT EXPENSE"

## Appendix F. Top 25 Frequently Occurring DRGs at MAMC, FY88

Code	Title
373	Vaginal Delivery without Complicating Diagnosis
390	Neonates with Other Significant Problems
391	Normal Newborns
183	Esophagitis, Gastroent. & Misc. Digest, Dis Age 18-69 w/o C. C.
379	Threatened Abortion
383	Other Antepartum Diagnoses with Medical Complications
372	Vaginal Delivery with Complicating Diagnosis
351	Sterilization, Male
370	Cesarean Section with C. C.
468	Unrelated OR Procedure
382	False Labor
187	Dental Extractions & Restorations
467	Other Factors Influencing Health Status
388	Prematurity w/o Major Problems
225	Foot Procedures
088	Chronic Obstructive Pulmonary Disease
243	Medical Back Problems
359	Uterus & Adnexa Proc for Non-Malignancy, Age <70 w/o C. C.
410	Chemotherapy
389	Full Term Neonate with Major Problems
222	Knee Procedures Age <70 w/o C. C.
039	Lens Procedure with or without Vitrectomy
381	Abortion with D&C Aspiration Curettage, or Hysterotomy
371	Cesarean Section w/o C. C.
125	Circulatory Disorders Exc AMI, with Card Cath w/o Complex Diag

## Appendix G. MAMC Length of Stay Data for Top 25 DRGs

Code	ALOS	S.D.	#Cases	CMI	Avg Age	#Male	#Female
373	3.15	3.00	1633	.4921	23.9	0	1633
390	3.03	1.28	1164	.2302	8.0	613	551
391	2.80	0.88	996	.1410	-	498	498
183	1.93	2.09	475	.5796	39.1	233	242
379	2.44	2.50	440	.3470	22.9	0	440
383	2.92	3.77	412	.3914	23.8	0	412
372	4.53	3.51	355	.8625	23.5	0	355
351	1.04	0.37	244	.3645	30.4	244	0
370	5.66	3.94	241	1.1346	24.2	0	241
468	7.85	11.51	228	1.9177	40.1	96	228
382	1.13	0.61	227	.1484	23.0	0	227
187	1.57	1.42	218	.5507	20.2	127	91
467	1.92	1.80	206	.3709	34.4	70	136
388	4.96	6.67	199	.9008	-	98	101
225	2.05	2.69	194	.7392	39.2	85	109
088	4.27	5.10	192	1.3000	63.3	97	95
243	9.19	8.10	193	.7964	37.7	122	71
359	6.42	3.34	186	1.0098	34.0	0	186
410	3.18	7.03	184	.7685	50.7	90	94
389	4.76	5.02	180	.5538	-	97	83
222	5.29	6.10	176	.9303	27.7	138	38
039	2.46	1.26	174	.7236	66.5	94	80
381	1.27	0.81	173	.3895	24.0	0	173
371	4.65	2.40	161	.9398	25.3	0	161
125	4.22	3.43	158	.8859	56.7	122	36

## Appendix H. University Hospital LOS Data for Selected DRGs

Code	ALOS	S.D.	#Cases	CMI	Avg Age	#Male	#Female
373	2.37	2.40	1009	.4075	24.4	0	1009
390	2.61	1.60	727	.5406	-	384	343
391	2.16	1.18	499	.2149	-	243	256
183	3.45	3.89	53	.5420	40.8	28	25
379	5.19	5.79	216	.3607	24.6	0	216
383	4.52	5.07	262	.4705	26.1	0	262
372	4.14	4.72	396	.5833	24.1	0	396
351	-	-	-	-	-	-	-
370	8.30	7.55	250	1.1587	27.0	0	250
468	10.73	10.73	104	2.3916	51.6	52	52
382	1.00	0.00	5	.1902	25.6	0	5
187	2.20	1.39	5	.5282	26.6	4	1
467	1.78	1.71	241	.5070	36.9	142	99
388	2.86	3.16	80	1.1571	-	31	49
225	3.13	1.78	39	.7164	37.2	16	23
088	5.14	5.17	14	1.0989	65.7	4	10
243	12.18	8.24	124	.6823	44.3	80	44
359	4.52	1.53	48	.9066	36.9	0	48
410	3.01	1.59	277	.4994	48.3	137	140
389	5.70	6.57	225	.8210	-	132	93
222	3.71	1.39	45	.8060	27.2	30	15
039	3.06	2.31	18	.5514	45.8	10	8
381	2.61	1.70	23	.3902	26.0	0	23
371	5.30	5.05	184	.8255	26.9	0	184
125	2.64	3.77	97	.7591	59.1	66	31

"REPRODUCED AT GOVERNMENT EXPENSE"

## Appendix I. Data Collection Instrument

### Data Collection Instrument

[illegible]

## Appendix J. Descriptive Statistics, DRG 125

## ----- DESCRIPTIVE STATISTICS -----

HEADER DATA FOR: C:DRG125 LABEL: RECORDS DATA FOR DRG 125  
 NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

## DRG 125, Circulatory Disorders

NO.	NAME	N	MEAN	STD. DEV.	MINIMUM	MAXIMUM
1	LOS	100	3.8000	2.7961	1.0000	16.0000
2	AD	100	.2100	.4094	.0000	1.0000
3	FM	100	.0100	.1000	.0000	1.0000
4	RT	100	.6200	.4878	.0000	1.0000
5	FR	100	.1400	.3487	.0000	1.0000
6	OT	100	.0200	.1407	.0000	1.0000
7	M	100	.8300	.3775	.0000	1.0000
8	S	100	.1400	.3487	.0000	1.0000
9	O	100	.0300	.1714	.0000	1.0000
10	SA	100	.0300	.1714	.0000	1.0000
11	MA	100	.1900	.3943	.0000	1.0000
12	TA	100	.2700	.4462	.0000	1.0000
13	WA	100	.2700	.4462	.0000	1.0000
14	THA	100	.1200	.3266	.0000	1.0000
15	FA	100	.0800	.2727	.0000	1.0000
16	SAA	100	.0400	.1969	.0000	1.0000
17	SD	100	.0100	.1000	.0000	1.0000
18	MD	100	.0700	.2564	.0000	1.0000
19	TD	100	.1100	.3145	.0000	1.0000
20	WD	100	.1500	.3589	.0000	1.0000
21	THD	100	.2900	.4560	.0000	1.0000
22	FD	100	.2500	.4352	.0000	1.0000
23	SAD	100	.1200	.3266	.0000	1.0000
24	PAT	100	.0000	.0000	.0000	.0000
25	HOME	100	.8100	.3943	.0000	1.0000
26	LTCF	100	.0000	.0000	.0000	.0000
27	ACF	100	.1900	.3943	.0000	1.0000
28	DCP	100	1.2500	.9679	1.0000	8.0000
29	LAB	100	67.6900	45.9063	25.0000	267.0000
30	XRAY	100	1.3500	1.0384	.0000	6.0000
31	CONS	100	.2200	.5427	.0000	2.0000
32	EMER	100	.3300	.4726	.0000	1.0000

"REPRODUCED AT GOVERNMENT EXPENSE"

## Appendix J. Descriptive Statistics, DRG 125 (continued)

## ----- FREQUENCY DISTRIBUTIONS -----

HEADER DATA FOR: C:DRG125 LABEL: RECORDS DATA FOR DRG 125  
 NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

VARIABLE: 1. LOS

## Distribution of LOS for DRG 125

===== VALUE =====	FREQUENCY	PERCENT	.....CUMULATIVE.... FREQUENCY	PERCENT
1.00	4	4.00	4	4.00
2.00	52	52.00	56	56.00
3.00	7	7.00	63	63.00
4.00	6	6.00	69	69.00
5.00	9	9.00	78	78.00
6.00	5	5.00	83	83.00
7.00	4	4.00	87	87.00
8.00	6	6.00	93	93.00
9.00	2	2.00	95	95.00
10.00	3	3.00	98	98.00
11.00	0	.00	98	98.00
12.00	1	1.00	99	99.00
13.00	0	.00	99	99.00
14.00	0	.00	99	99.00
15.00	0	.00	99	99.00
16.00	1	1.00	100	100.00
TOTAL	100	100.00		

=====CLASS LIMITS=====	FREQUENCY	.....
1.00	4	==
2.00	52	=====
3.00	7	==
4.00	6	==
5.00	9	=====
6.00	5	==
7.00	4	==
8.00	6	==
9.00	2	=
10.00	3	=
11.00	0	:
12.00	1	:
13.00	0	:
14.00	0	:
15.00	0	:
16.00	1	:

## Appendix K. Correlation Matrixes of Selected Variables, DRG 125

## ----- CORRELATION MATRIX -----

HEADER DATA FOR: C:DRG125 LABEL: RECORDS DATA FOR DRG 125  
 NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

## Correlation of Discharge Days and Friday Admission

	FA	SD	MD	TD	WD	THD	FD	SAD
FA	1.00000							
SD	-.02964	1.00000						
MD	.20803	-.02757	1.00000					
TD	.24975	-.03533	-.09645	1.00000				
WD	-.02065	-.04222	-.11525	-.14769	1.00000			
THD	-.10723	-.06423	-.17534	-.22468	-.26848	1.00000		
FD	-.08513	-.05803	-.15840	-.20297	-.24254	-.36899	1.00000	
SAD	-.10889	-.03711	-.10131	-.12982	-.15513	-.23600	-.21320	1.00000

CRITICAL VALUE (1-TAIL, .05) = + Or - .16551

CRITICAL VALUE (2-tail, .05) = +/- .19646

N = 100

## ----- CORRELATION MATRIX -----

HEADER DATA FOR: C:DRG125 LABEL: RECORDS DATA FOR DRG 125  
 NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

## Correlation of Admission Days and Thursday Discharge

	THD	SA	MA	TA	WA	THA	FA	SAA
THD	1.00000							
SA	-.11239	1.00000						
MA	-.14100	-.08517	1.00000					
TA	.70339	-.10695	-.29455	1.00000				
WA	-.33904	-.10695	-.29455	-.36986	1.00000			
THA	-.16819	-.06494	-.17885	-.22458	-.22458	1.00000		
FA	-.10723	-.05186	-.14282	-.17934	-.17934	-.10889	1.00000	
SAA	-.01799	-.03590	-.09886	-.12414	-.12414	-.07538	-.06019	1.00000

CRITICAL VALUE (1-TAIL, .05) = + Or - .16551

CRITICAL VALUE (2-tail, .05) = +/- .19646

N = 100

## Appendix L. Descriptive Statistics, DRG 222

## ----- DESCRIPTIVE STATISTICS -----

HEADER DATA FOR: C:DRG222 LABEL: RECORDS DATA FOR DRG 222  
 NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

## DRG 222, Knee Procedures

NO.	NAME	N	MEAN	STD. DEV.	MINIMUM	MAXIMUM
1	LOS	100	4.1400	2.3996	1.0000	11.0000
2	AD	100	.7900	.4094	.0000	1.0000
3	FM	100	.1300	.3380	.0000	1.0000
4	RT	100	.0300	.1714	.0000	1.0000
5	FR	100	.0400	.1969	.0000	1.0000
6	OT	100	.0100	.1000	.0000	1.0000
7	M	100	.5600	.4989	.0000	1.0000
8	S	100	.3500	.4794	.0000	1.0000
9	O	100	.0900	.2876	.0000	1.0000
10	SA	100	.0000	.0000	.0000	.0000
11	MA	100	.4000	.4924	.0000	1.0000
12	TA	100	.0400	.1969	.0000	1.0000
13	WA	100	.1600	.3685	.0000	1.0000
14	THA	100	.3100	.4648	.0000	1.0000
15	FA	100	.0800	.2727	.0000	1.0000
16	SAA	100	.0100	.1000	.0000	1.0000
17	SD	100	.0000	.0000	.0000	.0000
18	MD	100	.2500	.4352	.0000	1.0000
19	TD	100	.0800	.2727	.0000	1.0000
20	WD	100	.3400	.4761	.0000	1.0000
21	THD	100	.0900	.2876	.0000	1.0000
22	FD	100	.1500	.3589	.0000	1.0000
23	SAD	100	.0900	.2876	.0000	1.0000
24	PAT	100	.0400	.1969	.0000	1.0000
25	HOME	100	1.0000	.0000	1.0000	1.0000
26	LTCF	100	.0000	.0000	.0000	.0000
27	ACF	100	.0000	.0000	.0000	.0000
28	DCP	100	1.3100	1.2202	1.0000	8.0000
29	LAB	100	28.1400	11.2214	.0000	100.0000
30	XRAY	100	.6300	1.0314	.0000	4.0000
31	CONS	100	1.2800	.6369	.0000	3.0000
32	PASS	100	.4500	.9679	.0000	4.0000

"REPRODUCED AT GOVERNMENT EXPENSE"

## Appendix L. Descriptive Statistics, DRG 222 (continued)

## ----- FREQUENCY DISTRIBUTIONS -----

HEADER DATA FOR: C:DRG222 LABEL: RECORDS DATA FOR DRG 222  
 NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

VARIABLE: 1. LOS

## Distribution of LOS for DRG 222

===== VALUE =====	FREQUENCY	PERCENT	....CUMULATIVE....	
			FREQUENCY	PERCENT
1.00	3	3.00	3	3.00
2.00	40	40.00	43	43.00
3.00	3	3.00	46	46.00
4.00	18	18.00	64	64.00
5.00	6	6.00	70	70.00
6.00	5	5.00	75	75.00
7.00	17	17.00	92	92.00
8.00	5	5.00	97	97.00
9.00	1	1.00	98	98.00
10.00	0	.00	98	98.00
11.00	2	2.00	100	100.00
TOTAL	100	100.00		

=====CLASS LIMITS=====	FREQUENCY	.....
1.00	3	:=
2.00	40	:=
3.00	3	:=
4.00	18	:=
5.00	6	:=
6.00	5	:=
7.00	17	:=
8.00	5	:=
9.00	1	:=
10.00	0	:=
11.00	2	:=

## Appendix M. Correlation Matrixes of Selected Variables, DRG 222

## ----- CORRELATION MATRIX -----

HEADER DATA FOR: C:DRG222 LABEL: RECORDS DATA FOR DRG 222  
 NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

## Correlation of Discharge Days and Monday Admission

	MA	MD	TD	WD	THD	FD	SAD
MA	1.00000						
MD	-.14142	1.00000					
TD	-.16553	-.17025	1.00000				
WD	.57741	-.41439	-.21165	1.00000			
THD	-.04280	-.18157	-.09274	-.22572	1.00000		
FD	-.22866	-.24254	-.12388	-.30151	-.13211	1.00000	
SAD	-.25678	-.18157	-.09274	-.22572	-.09890	-.13211	1.00000

CRITICAL VALUE (1-TAIL, .05) = + Or - .16551

CRITICAL VALUE (2-tail, .05) = +/- .19646

N = 100

## ----- CORRELATION MATRIX -----

HEADER DATA FOR: C:DRG222 LABEL: RECORDS DATA FOR DRG 222  
 NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

## Correlation of Admission Days and Monday Discharge

	MD	MA	TA	WA	THA	FA	SAA
MD	1.00000						
MA	-.14142	1.00000					
TA	.11785	-.16667	1.00000				
WA	-.06299	-.35635	-.08909	1.00000			
THA	.26215	-.54728	-.13682	-.29253	1.00000		
FA	-.17025	-.24077	-.06019	-.12870	-.19765	1.00000	
SAA	-.05803	-.08206	-.02052	-.04386	-.06737	-.02964	1.00000

CRITICAL VALUE (1-TAIL, .05) = + Or - .16551

CRITICAL VALUE (2-tail, .05) = +/- .19646

N = 100

## Appendix N. Descriptive Statistics, DRG 359

## ----- DESCRIPTIVE STATISTICS -----

HEADER DATA FOR: C:DRG359 LABEL: RECORDS DATA FOR DRG 359  
 NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

## DRG 359, Uterus and Adnexa Procedures

NO.	NAME	N	MEAN	STD. DEV.	MINIMUM	MAXIMUM
1	LOS	100	6.1600	2.2144	1.0000	12.0000
2	AD	100	.2400	.4292	.0000	1.0000
3	FM	100	.5600	.4989	.0000	1.0000
4	RT	100	.0000	.0000	.0000	.0000
5	FR	100	.1700	.3775	.0000	1.0000
6	OT	100	.0300	.1714	.0000	1.0000
7	M	100	.8200	.3861	.0000	1.0000
8	S	100	.1300	.3380	.0000	1.0000
9	O	100	.0500	.2190	.0000	1.0000
10	SA	100	.0200	.1407	.0000	1.0000
11	MA	100	.1100	.3145	.0000	1.0000
12	TA	100	.0400	.1969	.0000	1.0000
13	WA	100	.2200	.4163	.0000	1.0000
14	THA	100	.2200	.4163	.0000	1.0000
15	FA	100	.3700	.4852	.0000	1.0000
16	SAA	100	.0200	.1407	.0000	1.0000
17	SD	100	.0600	.2387	.0000	1.0000
18	MD	100	.1800	.3861	.0000	1.0000
19	TD	100	.1400	.3487	.0000	1.0000
20	WD	100	.1100	.3145	.0000	1.0000
21	THD	100	.1800	.3861	.0000	1.0000
22	FD	100	.1800	.3861	.0000	1.0000
23	SAD	100	.1500	.3589	.0000	1.0000
24	PAT	100	.6800	.4688	.0000	1.0000
25	HOME	100	1.0000	.0000	1.0000	1.0000
26	LTCF	100	.0000	.0000	.0000	.0000
27	ACF	100	.0000	.0000	.0000	.0000
28	DCP	100	1.0600	.2778	1.0000	3.0000
29	LAB	100	54.8900	27.7798	7.0000	144.0000
30	XRAY	100	.5300	.9040	.0000	4.0000
31	CONS	100	.2200	.4623	.0000	2.0000
32	PASS	100	.8100	1.4333	.0000	7.0000

"REPRODUCED AT GOVERNMENT EXPENSE"

Appendix N. Descriptive Statistics, DRG 359 (continued)

----- FREQUENCY DISTRIBUTIONS -----

HEADER DATA FOR: C:DRG359 LABEL: RECORDS DATA FOR DRG 359  
 NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

VARIABLE: 1. LOS

Distribution of LOS for DRG 359

=====	VALUE	=====	FREQUENCY	PERCENT	....CUMULATIVE....	
					FREQUENCY	PERCENT
	1.00		1	1.00	1	1.00
	2.00		2	2.00	3	3.00
	3.00		3	3.00	6	6.00
	4.00		15	15.00	21	21.00
	5.00		24	24.00	45	45.00
	6.00		18	18.00	63	63.00
	7.00		13	13.00	76	76.00
	8.00		11	11.00	87	87.00
	9.00		4	4.00	91	91.00
	10.00		1	1.00	92	92.00
	11.00		7	7.00	99	99.00
	12.00		1	1.00	100	100.00
		TOTAL	100	100.00		

=====	CLASS LIMITS	=====	FREQUENCY	.....
	1.00		1	;
	2.00		2	;
	3.00		3	;
	4.00		15	;
	5.00		24	;
	6.00		18	;
	7.00		13	;
	8.00		11	;
	9.00		4	;
	10.00		1	;
	11.00		7	;
	12.00		1	;

## Appendix O. Correlation Matrixes of Selected Variables, DRG 359

## ----- CORRELATION MATRIX -----

HEADER DATA FOR: C:DRG359 LABEL: RECORDS DATA FOR DRG 359  
 NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

## Correlation of Admission Days and Sunday Discharge

	SD	SA	MA	TA	WA	THA	FA	SAA
SD	1.00000							
SA	-.03609	1.00000						
MA	-.08882	-.05022	1.00000					
TA	-.05157	-.02916	-.07176	1.00000				
WA	.37407	-.07587	-.18671	-.10841	1.00000			
THA	-.13418	-.07587	-.18671	-.10841	-.28205	1.00000		
FA	-.10640	-.10948	-.26942	-.15643	-.40700	-.40700	1.00000	
SAA	-.03609	-.02041	-.05022	-.02916	-.07587	-.07587	-.10948	1.00000

CRITICAL VALUE (1-TAIL, .05) = + Or - .16551

CRITICAL VALUE (2-tail, .05) = +/- .19646

N = 100

## ----- CORRELATION MATRIX -----

HEADER DATA FOR: C:DRG359 LABEL: RECORDS DATA FOR DRG 359  
 NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

## Correlation of Admission Days and Thursday Discharge

	THD	SA	MA	TA	WA	THA	FA	SAA
THD	1.00000							
SA	.30491	1.00000						
MA	-.08153	-.05022	1.00000					
TA	.03719	-.02916	-.07176	1.00000				
WA	-.18599	-.07587	-.18671	-.10841	1.00000			
THA	-.24882	-.07587	-.18671	-.10841	-.28205	1.00000		
FA	.34180	-.10948	-.26942	-.15643	-.40700	-.40700	1.00000	
SAA	-.06693	-.02041	-.05022	-.02916	-.07587	-.07587	-.10948	1.00000

CRITICAL VALUE (1-TAIL, .05) = + Or - .16551

CRITICAL VALUE (2-tail, .05) = +/- .19646

N = 100

Appendix O. Correlation Matrixes of Selected Variables, DRG 359  
(continued)

----- CORRELATION MATRIX -----

HEADER DATA FOR: C:DRG359 LABEL: RECORDS DATA FOR DRG 359  
NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

Correlation of Marital Status and Pass

	PASS	M	S	O
PASS	1.00000			
M	-.08067	1.00000		
S	.13490	-.82505	1.00000	
O	-.06595	-.48966	-.08868	1.00000

CRITICAL VALUE (1-TAIL, .05) = + Or - .16551

CRITICAL VALUE (2-tail, .05) = +/- .19646

N = 100

----- CORRELATION MATRIX -----

HEADER DATA FOR: C:DRG359 LABEL: RECORDS DATA FOR DRG 359  
NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

Correlation of Patient Category and Pass

	PASS	AD	FM	RT	FR
PASS	1.00000				
AD	.22263	1.00000			
FM	-.08984	-.63397	1.00000		
RT	99.99999	99.99999	99.99999	1.00000	
FR	-.14504	-.25432	-.51057	99.99999	1.00000

CRITICAL VALUE (1-TAIL, .05) = + Or - .16551

CRITICAL VALUE (2-tail, .05) = +/- .19646

N = 100

Appendix O. Correlation Matrixes of Selected Variables, DRG 359  
(continued)

----- CORRELATION MATRIX -----

HEADER DATA FOR: C:DRG359 LABEL: RECORDS DATA FOR DRG 359  
NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

-----

Correlation of Admission Days and Pass

	PASS	SA	MA	TA	WA	THA	FA	SAA
PASS	1.00000							
SA	-.08114	1.00000						
MA	-.19967	-.05022	1.00000					
TA	-.11594	-.02916	-.07176	1.00000				
WA	-.25086	-.07587	-.18671	-.10841	1.00000			
THA	-.06466	-.07587	-.18671	-.10841	-.28205	1.00000		
FA	.49423	-.10948	-.26942	-.15643	-.40700	-.40700	1.00000	
SAA	-.08114	-.02041	-.05022	-.02916	-.07587	-.07587	-.10948	1.00000

CRITICAL VALUE (1-TAIL, .05) = + Or - .16551

CRITICAL VALUE (2-tail, .05) = +/- .19646

N = 100

-----

## Appendix P. Descriptive Statistics, DRG 373

## ----- DESCRIPTIVE STATISTICS -----

HEADER DATA FOR: C:DRG373 LABEL: RECORDS DATA FOR DRG 373  
 NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

## DRG 373, Vaginal Delivery

NO.	NAME	N	MEAN	STD. DEV.	MINIMUM	MAXIMUM
1	LOS	100	3.1300	1.1604	2.0000	7.0000
2	AD	100	.1300	.3380	.0000	1.0000
3	FM	100	.8200	.3861	.0000	1.0000
4	RT	100	.0000	.0000	.0000	.0000
5	FR	100	.0300	.1714	.0000	1.0000
6	OT	100	.0200	.1407	.0000	1.0000
7	M	100	.9300	.2564	.0000	1.0000
8	S	100	.0400	.1969	.0000	1.0000
9	O	100	.0300	.1714	.0000	1.0000
10	SA	100	.1100	.3145	.0000	1.0000
11	MA	100	.1400	.3487	.0000	1.0000
12	TA	100	.0700	.2564	.0000	1.0000
13	WA	100	.1300	.3380	.0000	1.0000
14	THA	100	.1600	.3685	.0000	1.0000
15	FA	100	.2100	.4094	.0000	1.0000
16	SA <del>A</del>	100	.1800	.3861	.0000	1.0000
17	SD	100	.1600	.3685	.0000	1.0000
18	MD	100	.1600	.3685	.0000	1.0000
19	TD	100	.2000	.4020	.0000	1.0000
20	WD	100	.1100	.3145	.0000	1.0000
21	THD	100	.1200	.3266	.0000	1.0000
22	FD	100	.1600	.3685	.0000	1.0000
23	SAD	100	.0900	.2876	.0000	1.0000
24	PAT	100	.0000	.0000	.0000	.0000
25	HOME	100	1.0000	.0000	1.0000	1.0000
26	LTCF	100	.0000	.0000	.0000	.0000
27	ACF	100	.0000	.0000	.0000	.0000
28	DCP	100	1.0200	.1407	1.0000	2.0000
29	LAB	100	43.4500	17.2547	16.0000	159.0000
30	XRAY	100	.0000	.0000	.0000	.0000
31	CONS	100	.1000	.3015	.0000	1.0000
32	PREMAT	100	.0500	.2190	.0000	1.0000

"REPRODUCED AT GOVERNMENT EXPENSE"

Appendix P. Descriptive Statistics, DRG 373 (continued)

----- FREQUENCY DISTRIBUTIONS -----

HEADER DATA FOR: C:DRG373 LABEL: RECORDS DATA FOR DRG 373  
 NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

VARIABLE: 1. LOS

Distribution of LOS for DRG 373

===== VALUE =====	FREQUENCY	PERCENT	....CUMULATIVE....	
			FREQUENCY	PERCENT
2.00	31	31.00	31	31.00
3.00	43	43.00	74	74.00
4.00	17	17.00	91	91.00
5.00	3	3.00	94	94.00
6.00	3	3.00	97	97.00
7.00	3	3.00	100	100.00
TOTAL	100	100.00		

=====CLASS LIMITS=====	FREQUENCY	.....
2.00	31	=====
3.00	43	=====
4.00	17	=====
5.00	3	==
6.00	3	==
7.00	3	==

Appendix Q. Frequency Distributions for Discharge Planning

----- FREQUENCY DISTRIBUTIONS -----

HEADER DATA FOR: C:DRG125 LABEL: RECORDS DATA FOR DRG 125  
 NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

VARIABLE: 28. DCP

Discharge Planning, DRG 125

===== VALUE =====	FREQUENCY	PERCENT	....CUMULATIVE.... FREQUENCY PERCENT
1.00	87	87.00	87 87.00
2.00	10	10.00	97 97.00
3.00	1	1.00	98 98.00
4.00	0	.00	98 98.00
5.00	0	.00	98 98.00
6.00	0	.00	98 98.00
7.00	1	1.00	99 99.00
8.00	1	1.00	100 100.00
	TOTAL 100	100.00	

=====CLASS LIMITS=====	FREQUENCY	.....
1.00	87	=====
2.00	10	===
3.00	1	:
4.00	0	:
5.00	0	:
6.00	0	:
7.00	1	:
8.00	1	:-

Appendix Q. Frequency Distributions for Discharge Planning  
(continued)

----- FREQUENCY DISTRIBUTIONS -----

HEADER DATA FOR: C:DRG222 LABEL: RECORDS DATA FOR DRG 222  
NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

VARIABLE: 28. DCP

Discharge Planning, DRG 222

===== VALUE =====	FREQUENCY	PERCENT	....CUMULATIVE....	
			FREQUENCY	PERCENT
1.00	92	92.00	92	92.00
2.00	1	1.00	93	93.00
3.00	2	2.00	95	95.00
4.00	1	1.00	96	96.00
5.00	1	1.00	97	97.00
6.00	1	1.00	98	98.00
7.00	0	.00	98	98.00
8.00	2	2.00	100	100.00
	TOTAL 100	100.00		

=====CLASS LIMITS=====	FREQUENCY	.....
1.00	92	=====
2.00	1	:
3.00	2	:
4.00	1	:
5.00	1	:
6.00	1	:
7.00	0	:
8.00	2	:

Appendix Q. Frequency Distributions for Discharge Planning  
(continued)

----- FREQUENCY DISTRIBUTIONS -----

HEADER DATA FOR: C:DRG373 LABEL: RECORDS DATA FOR DRG 373  
NUMBER OF CASES: 100 NUMBER OF VARIABLES: 32

VARIABLE: 28. DCP

Discharge Planning, DRG 373

===== VALUE =====	FREQUENCY	PERCENT	....CUMULATIVE....	
			FREQUENCY	PERCENT
1.00	98	98.00	98	98.00
2.00	2	2.00	100	100.00
TOTAL	100	100.00		

=====CLASS LIMITS=====	FREQUENCY	.....
1.00	98	=====
2.00	2	;

## Works Cited

- AHA Guide. American Hospital Association, Chicago, 1988.
- Brennan, L. "DRG Strategies from the Big 8." Medical Laboratory Observer 1985 Jan; 17(1): 45-51.
- Carroll, N. V. and W. G. Erwin. "Patient Shifting as a Response to Medicare Prospective Payment." Medical Care 1987 Dec; 25(12): 1161-7.
- Cohen, A. M., N. Schaeffer, Z. Y. Chen, and W. C. Wood. "Early Discharge After Modified Radical Mastectomy." American Journal of Surgery 1986 Apr; 151(4): 465-6.
- Crawford, M. "Implementing Medicare Prospective Pricing by Diagnosis Related Groups." Ala J Med Sci 1984 Jan; 21(1): 96-100.
- Directory of Graduate Medical Education Programs 1988-1989. American Medical Association, Chicago, 1988.
- Egdahl, R. H. "Ways for Surgeons to Increase the Efficiency of Their Use of Hospitals." New England Journal of Medicine 1983 Nov 10; 309(19): 1184-7.
- Feldman, J. and F. I. Goldhaber. "Living with DRGs." Journal of Nursing Administration 1984 May; 14(5): 19-22.
- Fitzgerald, J. F., L. F. Fagan, W. M. Tierney, and R. S. Dittus. "Changing Patterns of Hip Fracture Care Before and After Implementation of the Prospective Payment System." JAMA 1987 Jul 10; 258(2): 218-21.
- Hall, R. C. "Short Surgical Stay: Two Hospital Days for Cholecystectomy." American Journal of Surgery 1987 Nov; 154(5): 510-15.

- Helml, M.A. "Cost Control under the DRG System." Hospital and Health Services Administration 1988 Summer; 33(2): 263-269.
- Jay, J. R. "Five Proven Ways to Come Out Ahead Under DRGs." Hospital Medical Staff 1984 Jun; 13(6): 26-30.
- Johnson, S. H. "Implementing DRGs in Critical Care Nursing." Dimensions in Critical Care Nursing 1985 Mar-Apr; 4(2): 67-8.
- Jones, K. R. "Predicting Hospital Charge and Stay Variation. The Role of Patient Teaching Status, Controlling for Diagnosis-Related Group, Demographic Characteristics, and Severity of Illness." Medical Care 1985 Mar; 23(3): 220-35.
- Marchette, Lisa and Faye Holloman. "Length of Stay: Significant Variables." Journal of Nursing Administration 1986 March; 16(3): 12-20.
- May, J. J. "Impact of Diagnosis Related Groups on Medical Practice." American Journal of Cardiology 1985 Aug 23; 56(5): 16C-26C.
- McMahon, L. F., Jr. and R. Newbold. "Variation in Resource Use Within Diagnosis-Related Groups. The Effect of Severity of Illness and Physician Practice." Medical Care 1986 May; 24(5): 388-97.
- Munoz, E., I. B. Margolis, and L. Wise. "Surgonomics and Cost Containment." Surgery, Gynecology, & Obstetrics 1986 Feb; 162(2): 137-41.
- Munoz, E., R. Soldano, H. Gross, D. Chaflin, K. Mulloy, and L. Wise. "Diagnosis Related Groups and the Transfer of

General Surgical Patients." Archives of Surgery 1988 Jan;  
123(1): 68-71.

Portugal, B. and J. Winkelman. "The Future of Hospital  
Laboratories: Planning Strategies for the Next Decade."  
32nd Congress on Administration, ACHE. Chicago, 15 Feb.  
1989.

Rosko, M. D., and R. W. Broyles. "Short-term Responses of  
Hospitals to the DRG Prospective Pricing Mechanism in New  
Jersey." Medical Care 1987 Feb; 25(2): 88-99.

Thompson, J. D. and K. L. Grazier. "Incorporating DRGs Into  
Medical and Management Education." Journal of Health  
Administration Education 1984 Summer; 2(3): 261-9.

Triservice Performance Measurement Group. "State-of-the-state of  
DRG Implementation Pursuant to P.L. 99-661." U.S. Army  
Health Care Studies and Clinical Investigations Activity;  
Fort Sam Houston, Texas: 1987.

Vander Salm, T. J. and S. A. Blair. "Effect of Reduction of  
Postoperative Days in the Intensive Care Unit After Coronary  
Artery Bypass." Journal of Thoracic and Cardiovascular  
Surgery 1984 Oct; 88(4): 558-61.